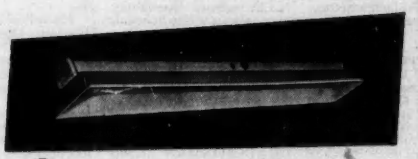
into one will go

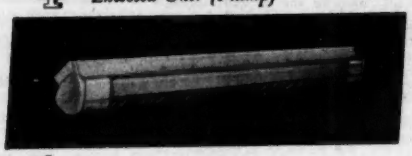


1 *Closed End Metal Trough*

2 *Open End Metal Trough*

3 *Closed End Translucent Trough*

4 *Enclosed Unit (1-lamp)*



5 *Louvre Unit (1-lamp)*

ese METROVICK 5-foot fluorescent
its all utilise a standard basic channel
which the instant start or switch
r is housed. They are suitable for
ain, conduit or direct ceiling
unting. Erection of the ceiling
unting type is greatly simplified
the use of slotted backplates and
reshoe washers which support
unit during fixing. Turret lamp
ders permit easy replacement
amps from either end.
ETROVICK 5 ft. fluorescent
ngs are constructed of sheet
el, bonderised and with a
e enamel finish.

METROVICK 5ft
fluorescent fittings

ROPOLITAN-VICKERS ELECTRICAL CO. LTD.
AUL'S CORNER, ST. PAUL'S CHURCHYARD, LONDON, E.C.4
Member of the A.E.I. group of companies.

S/A407

THE ENGINEER

ESTABLISHED 1856

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

UNIVERSITY OF WESTERN AUSTRALIA

LECTURER IN ELECTRICAL ENGINEERING

Applications are invited for the position of LECTURER IN ELECTRICAL ENGINEERING.

Applicants should hold a Degree in Engineering and preference will be given to an applicant with experience or interest in some aspect of heavy power electrical engineering such as modern methods of system analysis or some aspect of electrical design.

The salary range, which is under review at present, is £859–£50–£1259 (Australian) per annum, which includes a present cost-of-living allowance of £259. According to qualifications and experience an appointment may be made within the range.

An allowance is made towards travelling expenses.

The successful applicant will be expected to commence duties as early as possible in 1955.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5, Gordon Square, London, W.C.1.

The closing date for the receipt of applications, in Australia and London, is 30th October, 1954.

E5617

THE UNIVERSITY OF LIVERPOOL

CHAIR OF FLUID MECHANICS

The Council of the University of Liverpool invites applications for the newly established CHAIR OF FLUID MECHANICS.

Further particulars may be obtained from the undersigned, by whom twelve copies of applications (one in the case of overseas candidates) should be received not later than 6th November, 1954.

STANLEY DUMBELL,
Registrar.

E5627

LONDON COUNTY COUNCIL

NORWOOD TECHNICAL COLLEGE

PRINCIPAL

Applications invited for post of PRINCIPAL of Norwood Technical College, Knights Hill, S.E.27, to commence, if possible, on 1st January, 1955.

Salary scale, £1240 by £50 to £1390, subject to review under Burnham (Further Education) Report, 1954.

Applicants should have teaching and organising experience necessary to administer a well-equipped college. Professional or industrial experience an advantage.

The college has three departments ((a) Telecommunications and Physics, (b) Chemistry and Biology, (c) Commercial and Literary) open for full-time and part-time day and evening courses for B.Sc. (General), A.R.I.C., National Certs., in Physics and Chemistry, C. and G. Certs. in Telecomms. Engineering, P.M.G. Certs. and G.C.E. at Ordinary and Advanced levels. Courses are provided for secretarial and commercial students from G.C.E. level, for accountants, bankers and secretaries, and in speech-training languages, literature, music and drama.

Further particulars and application forms from Education Officer (T.3), County Hall, London, S.E.1, for return by 30th October, 1954. (1242.)

E5607

COUNTY BOROUGH OF BRIGHTON EDUCATION COMMITTEE

BRIGHTON TECHNICAL COLLEGE

Principal: G. E. WATTS, M.A., Ph.D. (Cantab), B.Sc. (Lond.), F.R.I.C.

ASSISTANT LECTURER

Required as soon as possible :—

ASSISTANT LECTURER (Grade B) in MECHANICAL ENGINEERING with special reference to Theory of Machines and Engineering Drawing for Degree and diploma courses. Applicants should hold a Degree or equivalent qualification in Mechanical Engineering.

Salary £525 by £25 to £820, plus Graduate allowance £60, and increments for approved training and/or industrial experience.

Further particulars and application forms may be obtained from the undersigned. Completed forms should be returned to the Principal, Brighton Technical College, Brighton, 7, within fourteen days.

W. G. STONE,
Director of Education.

Education Office,
54, Old Steine,
Brighton, 1.

E5695

THE COLLEGE OF AERONAUTICS

DEPARTMENT OF AIRCRAFT ELECTRICAL AND ELECTRONIC ENGINEERING

LECTURESHIP IN AIRCRAFT ELECTRICAL POWER SYSTEMS

Applications are invited for a LECTURESHIP IN AIRCRAFT ELECTRICAL POWER SYSTEMS. The Lecturer will be concerned mainly with the study of complete systems, but may also have to lecture on the design of individual components. Applicants must be graduates and/or have passed the examination of the Institution of Electrical Engineers, and should have experience in either the analysis of A.C. systems or automatic control. Aircraft experience is desirable, but not essential. Salary will be within the range £600–£1000, with F.S.S.U. and family allowance.—Further information may be obtained from The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks, with whom applications, quoting not more than three referees, should be lodged by December 1st, 1954. E5654

PUBLIC APPOINTMENTS

PUBLIC SERVICE OF SOUTH AUSTRALIA

HARBORS BOARD

CHIEF ENGINEER

Applications for the above-mentioned position should be made in writing to the Agent-General for South Australia, South Australia House, Marble Arch, London, W.1, setting out full names, address, date of birth, marital status, academic qualifications, practical experience and particulars of war service (if any). Copies of testimonials should be submitted with the application.

CHIEF ENGINEER. Salary range: £A2027/£A2147 per annum.

Applications are invited for the position of CHIEF ENGINEER of the SOUTH AUSTRALIAN HARBORS BOARD, a State Ports Authority charged with the administration, development and maintenance of the deep sea ports of Adelaide, Pirie, Wallaroo, Lincoln and Thevenard, and also 50 minor outports.

Applicants should be not more than 50 years of age, holders of approved University Degrees in Engineering, or Corporate Members of the Institution of Civil Engineers, London, or Institution of Engineers, Australia, who have specialised in port and harbor engineering.

The Chief Engineer will have responsibility for an engineering organisation at present numbering approximately 100 staff and 650 other employees, undertaking the design, construction and maintenance of engineering works and port installations. These include wharves and piers in reinforced concrete, steel and timber; retaining walls in steel sheet piling and reinforced concrete; piled foundations, steel-framed transit sheds and port buildings generally; the mechanical equipment of wharves including electrically operated wharf cranes for general and heavy duty; electric power and lighting; major bulk coal and grain handling installations; breakwaters and earthworks. He will also be responsible for a fairly large dockyard engineering establishment; the maintenance and operation of a considerable fleet of dredgers, tugs, barges and other floating plant; the execution of major dredging and reclamation works; the installation and maintenance of aids to navigation; and the use and upkeep of a wide range of construction plant.

Administrative capacity of a high order and ability to lead and co-ordinate the work of other qualified engineers are essential qualifications. E5697

HER MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT, SOMALILAND PROTECTORATE

EXECUTIVE ENGINEER

Applications are invited for the following post :—

EXECUTIVE ENGINEER, Public Works Department, Somaliland Protectorate.

Duties: Responsibility for design and construction of roads, water supplies, buildings and general civil engineering projects. Appointment on probation for permanent and pensionable establishment.

Basic salary according to age, qualifications and experience in incremental scale £655–£1310 p.a., plus temporary variable, non-pensionable cost-of-living allowance, at present payable at rate of 30 per cent. of basic salary (maximum £300 per annum).

Candidates must hold a recognised University Degree or diploma in Civil Engineering carrying exemption from Final Parts I and II of the A.M.I.C.E. examination, plus at least three years' approved practical experience, or be A.M.I.C.E.

Full details on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD 112/5/02/D4.

E5680

BRITISH ELECTRICITY AUTHORITY

NORTH-WEST, MERSEYSIDE AND NORTH WALES DIVISION

SENIOR DRAUGHTSMAN

Applications are invited for the appointment of SENIOR DRAUGHTSMAN (MECHANICAL) in the Construction Department, Liverpool Office, Springwood House. Salary £567/£671 per annum, Grade 5, Schedule "D" to the National Joint Board Agreement. Superannuable and subject to medical examination.

Applicants should have had a good general and technical education, preferably possess the Higher National Certificate in Engineering, and have had some experience in a drawing-office associated with the construction of modern power stations or allied plant. The successful applicant will be required to prepare drawings and diagrams associated with power station plant and equipment, and check drawings and diagrams submitted by contractors.

Application forms from the Divisional Controller, Beaconsfield Road, Woolton, Liverpool. Closing date, the 8th October, 1954. E5661

NATIONAL COAL BOARD

DURHAM DIVISION

ENGINEERING DRAUGHTSMEN

ENGINEERING DRAUGHTSMEN required at Washington, Sunderland and South Shields. Applicants should be experienced in the design and construction of colliery handling plant, structural and mechanical equipment. Experience in connection with colliery reconstruction scheme and the possession of a technical qualification would be an advantage. Write with full particulars of qualifications, age and experience, to Area Secretary, National Coal Board, Durham Division, No. 1 Area, Station Road, South Shields. E5690

PUBLIC APPOINTMENTS

BRITISH ELECTRICITY AUTHORITY

MIDLANDS DIVISION

APPOINTMENTS

Applications are invited for the following appointments in the Generation (Construction) Department at Wolverhampton. N.J.B. service conditions superannuable appointments, salaries within Schedule "D" of the Agreement :—

(a) TWO SENIOR DRAUGHTSMEN (Mechanical) Grade 5 (Vacancy No. 765MD).

(b) ONE ENGINEERING DRAUGHTSMAN (Mechanical) Grade 6 (Vacancy No. 766MD).

(c) ONE SENIOR DRAUGHTSMAN (Structural Steelwork) Grade 5 (Vacancy No. 767MD).

(d) TWO SENIOR DRAUGHTSMEN (Architectural) Grade 5 (Vacancy No. 768MD).

(e) ONE SENIOR DRAUGHTSMAN (Civil) Grade 5 (Vacancy No. 769MD).

(f) ONE ENGINEERING DRAUGHTSMAN (Civil) Grade 6 (Vacancy No. 770MD).

Applicants for these positions should have received a sound technical training and practical experience, in particular for :—

(a) and (b) in the layout of plant for new generating stations including turbines, boiler or similar plant.

(c) In the design of heavy steel structures, preferably with works training in steel fabrication.

(d) In the layout and design of main and auxiliary buildings associated with power stations; and

(e) and (f) General civil engineering, preferably associated with power stations.

Appropriate technical qualifications will be an advantage; opportunities for advancement; good conditions of employment and holidays. Salary ranges, Grade 5, £567 to £671, and Grade 6, £433 to £567. Previous applicants for these positions will be reconsidered.

Apply, quoting the vacancy number, on Form AE6, available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 9th October, 1954. E5694

NATIONAL COAL BOARD

LONDON HEADQUARTERS

DESIGNER-DRAUGHTSMAN, TRACER

National Coal Board invite applications for the undermentioned superannuable appointments in their production Department Engineering Drawing-Office at London Headquarters.

DESIGNER-DRAUGHTSMAN. Candidates must be experienced in the design of mechanical equipment, preferably underground mining machinery, and they must be able to carry through design work from the project to the manufacturing stages. Experience in the design of hydraulic equipment would be an advantage. A Higher National Certificate or equivalent qualification is desirable. Salary, according to qualifications and experience, will be in the inclusive range £622–£750 per annum. (Ref. No. TT/837.)

TRACER, preferably with experience in the production of high-quality ink tracings on linen of mechanical engineering drawings. Salary, according to age and ability, will be up to a maximum of £8 3s. 6d. per week. (Ref. No. TT/838.)

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope with the relevant T.T. reference number quoted above. Original testimonials should not be forwarded. Closing date 5th October, 1954. E5626

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ASSISTANT EXPERIMENTAL OFFICERS

Department of Scientific and Industrial Research require ASSISTANT EXPERIMENTAL OFFICERS (unestablished) at the Hydraulics Research Station, Wallingford, as follows :—(1) Civil Engineer for experimental work on hydraulic models of rivers, estuaries, harbours, &c. (Ref. E606/54/A); (2) Mechanical Engineer, for work on mechanical design of instruments, workshop experience desirable (Ref. C650/54/A); (3) Electrical Engineer, for work on electrical design of instruments, workshop experience desirable (Ref. D468/54/A). Candidates should be at least 18 and have H.N.C. in engineering subjects or G.C.E. at advanced level in Scientific or Mathematical subjects or equivalent qualification. Candidates over 22 should normally have H.N.C. or a Pass Degree. Inclusive annual remuneration for a 45½-hour week, £284–£633 (men); £284–£530 (women), according to age. Favourable housing prospects for married candidates. Prospects of permanent establishment for candidates under 28.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting appropriate reference. Closing date 16th October, 1954. E5631

ADMIRALTY

ROYAL NAVAL SCIENTIFIC SERVICE

SCIENTIFIC OFFICERS

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS required in Experimental Establishments in London, Portsmouth, Weymouth and Gloucestershire areas and Scotland. The majority of posts are for Engineers and Physicists (particularly with electronics). Candidates must be British subjects with an appropriate First or Second Class Honours Degree or equivalent high professional attainments. Salaries: S.S.O. (M.), £975–£1150; S.O. (M.), £470–£855. London rates. Somewhat lower in Provinces. All appointments are unestablished (with F.S.S.U.), but with some opportunities to compete for established posts.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A 246/52/A. E5633

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

TRANSPORT AND HARBOUR DEPARTMENT, BRITISH GUIANA

APPOINTMENTS

The following vacancies exist in the Transport and Harbours Department, British Guiana :—

(a) CIVIL ENGINEER (BCD 119/30/04/D3).

Duties include the construction and maintenance of passenger and goods stations and other buildings on a small railway; remodelling of existing stations and sidings; rehabilitation of existing jetties in brick or timber; construction of new jetties and wharves. Some railway and wharf experience essential, and experience of level crossings and signalling desirable.

(b) PORT ENGINEER (BCD 119/30/05/D4).

Duties include the design, estimating for construction and maintenance of warehouses, jetties of timber wharves in tidal estuaries; of extensions to minals for through loading ferry boats on tidal estuaries, and the enlargement and repair of existing dry dock. Candidates must be experienced in tidal and estuary work.

(c) MECHANICAL ENGINEER (BCD 119/30/06/D4).

Duties include the erection, operation and maintenance of new locomotives, rolling stock and workshops, the handling of machinery and responsibility for workshops production, and maintenance of locomotives and rolling stock. Candidates should have workshop and running experience preferably in steam and diesel engines desirable.

Candidates for all three posts should be between 28 and 45 years of age.

For posts (a) and (b) they must hold a recognised University Degree or Diploma in Civil Engineering which carries exemption from, or have passed Parts I and II of the A.M.I.C.E. Examination, plus at least two years' approved practical experience.

For post (c) they must hold a recognised University Degree or Diploma in Mechanical Engineering which carries exemption from Parts A and B of the A.M.I.Mech.E. Examination, plus at least five years' training in industrial mechanical engineering workshops.

Appointments are on contract gratuity terms for two years' resident service, with possibility of further extension, at a fixed salary of £1500 per annum, plus gratuity of 22½ per cent of basic salary payable at the end of each completed period of six months' satisfactory service.

For full details apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving brief details of age, qualifications and experience, and quoting relevant reference number.

THE NEWCASTLE AND GATESHEAD WATER COMPANY

ASSISTANT ENGINEER

Applications are invited for the appointment of ASSISTANT ENGINEER.

Candidates must be chartered civil engineers who have had sound experience in the design and construction of civil engineering works, preferably, but not necessarily, related to a public water undertaking.

The salary for the post will commence at a point in A.P.T. Grades VII and VIII, i.e. between £760 and £860 per annum, commensurate with the qualifications and experience of the successful candidate.

A contributory superannuation scheme, with condition of service for permanent officers of the company.

Applications, containing particulars of qualifications and experience, and copies of not more than two recent testimonials, are to be addressed to the undersigned by 23rd October, 1954.

W. B. ATKIN,
Secretary and General Manager.

G.P.O. Box No. 104,
Pilgrim Street,
Newcastle upon Tyne, 1.

BRITISH ELECTRICITY AUTHORITY

EASTERN DIVISION

SENIOR DRAUGHTSMEN (MECHANICAL)

Applications are invited for the following appointments in the Generation (Construction) Department at Divisional Headquarters :—

SENIOR DRAUGHTSMEN (MECHANICAL). Salary Schedule D, Grade 4, £704–£819 per annum.

The commencing salary (which includes any weighting) will depend upon experience and qualifications. Applicants should preferably have experience in generation station plant layout, particularly of pipework, coal, ash and dust handling plant.

Applications, stating age, qualifications and experience, should be sent to the Controller (Personnel), Electricity Authority, Eastern Division, Thorpe House, Southgate, N.14, by 2nd October, 1954.

W. N. C. CLAY,
Chairman.

E5641

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

GRADUATE

GRADUATE required by the above Association for work concerned with experimental redesign of control points in steelworks plant for human operator. An interest in this type of work is essential. Some knowledge of electrical engineering is desirable; age 22–25. Salary according to age, qualifications and experience in the range £525–£650 p.a. Post is superannuable under the F.S.S.U. Location of work, London. Written applications only, quoting "G," to Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1.

THE ENGINEER

SEPTEMBER 24, 1954

International Internal Combustion Engine Congress

IN a note which appeared in our issue of March 12th of this year we drew attention to a letter circulated by the organisers of the International Combustion Engine Congress Appeal. This letter asked for support for British participation in the International Internal Combustion Engine Congress to be held at The Hague in May, 1955, and for financial support to maintain a secretariat in Paris. It was also emphasised that Britain was not officially represented at either the Paris Congress of 1951 or the conference held in Milan in 1953. Subsequent to the circulation of the letter a meeting was held in London on September 15th of representatives of the internal combustion engine and related industries and as a result it was decided that the United Kingdom would be represented officially at future International Internal Combustion Engine Conferences. As a result of this decision a British National Committee was formed and at present consists of representatives of the following organisations: British Internal Combustion Engine Manufacturers' Association; British Internal Combustion Engine Research Association; National Association of Marine Engine Builders; National Forgemasters' Association; Locomotive Manufacturers' Association, and the Diesel Engine Users Association. It was proposed at the meeting that the committee should consist of twelve members and the committee, as constituted, has the power to co-opt representatives of other bodies to bring the membership up to the total as stated. Some twenty-three firms and associations are giving active support to the arrangements for official British participation in the congresses and it is confidently expected that further support for this move for official representation will be forthcoming from other bodies. The next session of the Congress, to be held at The Hague in May of next year, will deal with the use of diesel engines for rail traction and of large diesel engines for stationary and marine applications. Those wishing to attend the Congress or requiring accommodation are advised by the committee to address their enquiries to the Secretary of the National Committee, care of the British Internal Combustion Engine Manufacturers' Association, 6, Grafton Street, London, W.1, and not to the organisers at The Hague or the permanent Secretariat in Paris, the Association having undertaken to act as the permanent Secretariat of the British National Committee.

British Standards Institution

THE work of the British Standards Institution during the year ended March 31st last has been surveyed in the annual report which has just been published. The report says that during the year there was again an increase in activity and output, the number of new and revised standards issued being 286, compared with 260 in the preceding year and 227 in the year 1951–52. The number of subscribing members of the Institution now exceeds 8000; there are 2388 standing committees and last year 3420 committee meetings were held. The report includes chapters dealing specifically with the work of the Institution's four divisional councils—building, chemical, engineering and textiles—and gives some notes about the standards published during the year and about the projects which are in hand. There is also presented in the report some information about the assistance which the British Standards Institution is rendering to the development of the export trade. With the increasing volume and scope of the overseas work connected with standards, and the growing importance of standards as affecting exports, it was decided last year to review the arrangements provided within the B.S.I. committee structure. After consultation with a number of leading industrialists and with the Federation of British Industries, it was agreed to replace the existing oversea standards advisory committee by a small panel of eight or nine people with expert knowledge of export matters. The function of this panel is to advise the executive committee of the British Standards Institution on major policy considerations relating to overseas trade. Another matter referred to in the report is under the heading of "Anglo-American Terminology." It is recalled that, two years ago, an agreement was reached with representatives of the American Standards Association that an endeavour should be made to co-ordinate terms and definitions used in the United Kingdom and in the U.S.A. in various fields of industry. The B.S.I. says that in the fields so far selected "quite encouraging progress has been made."

National Smoke Abatement Society's Conference

THE annual conference of the National Smoke Abatement Society, which opened at Scarborough on Wednesday last, will conclude to-day. In his opening address, the president, Sir Ernest Smith, said that we were at the beginning of a revolution in the way we obtained and used energy. Although nuclear energy was coming and energy might be obtained from other sources, there was no choice for the immediate future but to continue to rely mainly on coal, even though it was bound to become scarcer, more difficult to mine and less satisfactory in quality. Sir Ernest paid tribute to advances that had been made in recent years in three of the major coal-consuming industries, as a result of which 47,000,000 tons of coal a year were being saved. In electricity generation the fuel saved in 1952 by the improvement of efficiency over 1925 amounted to over 27,000,000 tons. The gas industry also showed considerable advance and saved 3,200,000 tons of coal compared with what would have been used at 1925 efficiency. The coal used in the iron and steel industry in 1952 was 26,900,000 tons; with efficiency at the 1925 level consumption would have been 43,700,000 tons. Sir Hugh Beaver, chairman of the Government Committee on Air Pollution, said that his committee had virtually completed its report, which would soon be in the hands of Ministers, and he could not, of course, anticipate its findings. In discussing the problem of smoke in connection with the railways, Mr. R. F. Harvey dealt with the measures being taken to cut down the smoke from coal-fired locomotives. He said that the British Transport Commission was keenly alive to the problem of air pollution, and investigations had been made recently to determine the causes of the smoke from the railways. There were 700 to 800 steam locomotives in use within 10 miles of Charing Cross, and observations showed that less than 15 per cent of these were emitting smoke darker than a grey haze. Investigations had shown that 75 per cent of the instances of smoke came from around the motive power depots, and only 6 per cent from the main line termini.

Opening of Exeter Waterworks Pumping Station

EXETER'S water supply is obtained from the River Exe, with a purification and pumping plant at Pynes waterworks, from whence various service reservoirs are supplied. The average consumption of the city is almost 4 m.g.d., and a peak figure of 5 m.g.d. has been recorded. It was apparent after the war that the existing pumping plant at Pynes was obsolete, and a reconstruction scheme for the pumping station was prepared, upon which work has now been completed. The new pumping station was opened on September 14th; its construction cost nearly £125,000. Water power is used to the fullest possible extent in the new pump house, with the additional output provided by electrically-driven pumps, with stand-by diesel pumps. The capacity of the station is based upon the 5·4 m.g.d. which is the authorised maximum rate of abstraction, with allowance for peak loads and the inability to pump at a regular rate for twenty-four hours, because of the limited capacity of the high service reservoirs. The plant comprises five main units totalling 741 b.h.p., two of them water powered (250 b.h.p.) and three electrically powered, two stand-by diesel pumps, an existing stand-by steam pump and a diesel-powered alternator; the stand-by units total 797 b.h.p. The water turbines are 45in diameter vertical shaft Francis machines, working at 83·5 r.p.m. under an average head of 8ft, which in a year of average rainfall will supply the full power required for eight months out of twelve. They each drive a centrifugal pump through speed-increasing gears, one pump for "high" service (about 315ft head) and the other for "low" service (about 150ft head). These two pumps may also be electrically driven. The civil engineering works for the new pump house included the construction of a circular suction well outside the pump house, a bridge over the pump house to carry mains, alternators to the leat and weirs, and extensive reinforced concrete works in the pump house substructure. The new works were designed and constructed under the supervision of the city and water engineer of Exeter; the main contractors were W. H. Allen Sons and Co., Ltd., the Hadsphaltic Construction Company, Ltd., and Stephens and Sons, Ltd., and some of the work was done by direct labour.

Air Pollution

LAST week the National Union of Manufacturers issued a summary of the views it submitted to the Beaver Committee on Air Pollution. This summary states that the union is in full agreement with the view expressed in the interim report of the committee that smoke prevention and fuel economy are two aspects of the same question. During the last few years the union has repeatedly pressed for an intensification of fuel economy measures and has actively supported the fuel saving policy of the Ministry of Fuel and Power. It is pointed out that fuel economy is an end itself, but it is derived from fuel efficiency which automatically means less smoke. The union does not consider that there is any need for further legislation to prevent air pollution by industry, but what is required is a positive appeal to enlightened self-interest. An incentive policy is required and an effective incentive would be to allow capital expenditure on fuel efficiency to be charged against revenue in the year in which the expenditure is incurred. Given the taxation incentive which had been recommended the summary states that it should be practical economics for the large majority of the 26,000 coal-consuming factories to fit steam-raising plant with mechanical stokers. This by itself would do much to solve the problem of industrial smoke emission. It is pointed out that the National Union of Manufacturers has long urged that boiler house staff should be trained properly. Employers should ensure that boiler house operatives are suitably qualified and that operatives should also be paid more for being so qualified.

Method of Preventing Fatigue Failure of Steel Bolts

By R. H. CROSS and G. M. NORRIS

It is shown that locking two nuts together can prevent fatigue failure of a bolt in tension by effecting a reduction in the alternating load borne by the peak loaded thread immediately inside the inner face of the inner nut. Fatigue tests on ¾in B.S.F. bolts with two locked nuts show that the magnitude of the inter-nut torque determines whether or not fatigue failure will occur.

THE position of maximum stress in a bolt in direct tension has been shown to occur in the fillets of the peak-loaded threads immediately inside the contacting face of the nut. Efforts made to increase the fatigue strength of the bolt and nut fastening have consequently been directed towards the achievement of a more uniform stress distribution throughout the length of the nut. The most suitable method theoretically is to make the pitch of the nut threads greater than that of the bolt threads. This is, however, difficult to attain in practice because of the small differences in pitch necessary.

An effect comparable with that produced by differential pitching may be obtained by application of an inverse load at the free face of the nut. This may conveniently be carried out by screwing up a second nut tightly against the free face of the first.

Theory

When two nuts are locked together on the same bolt the thread load per unit length of helix w along the length of each nut has equal values, but is opposite in sign at points the same distance from the junction of the nuts. The shape of each load distribution curve will be similar to that along a single nut on a bolt in tension, the load falling from a peak value at contact in the manner shown in Figs. 1 (*a*) and 1 (*b*). The general form of the curves is based on mathematical analysis by Sopwith[1] and on experiments by Goodier[2] and Hetenyi.[3]

The effect of applying a static tensile load to a bolt with two nuts is shown by the two broken distribution curves in Fig. 1 (*c*). Simple algebraic application of the principle of superposition gives the net load distribution along each nut (Fig. 1 (*d*)). Three points are noted :—

(i) The peak load at the inner face of the inner nut is less than that at the inner face of a single nut for the same applied load ((*a*) and (*d*), Fig. 1).

(ii) The resultant distribution curve passes through zero load.

(iii) The peak load at the contacting face of the outer nut is increased.

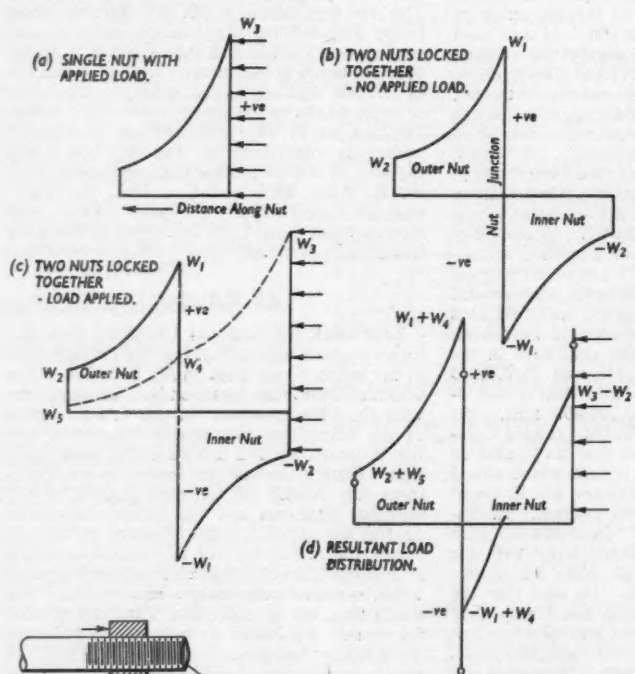
In the case of a single nut about 75 per cent of the total applied load flows into the first one or two turns of the bolt thread nearest the contacting face of the nut.

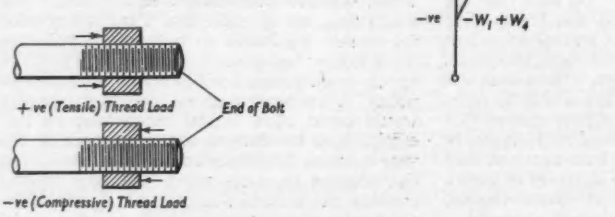
The greater fatigue strength obtained by the use of a locking nut thus lies in the reduced alternating load on the corresponding bolt threads in the inner nut. The amount of reduction is transmitted by the contacting faces of the nuts and carried mainly by the peak-loaded threads in the outer nut. The manner in which the alternating load is distributed between the two nuts thus becomes the deciding factor under fatigue conditions.

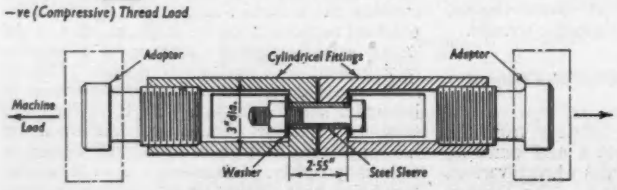
Fatigue Tests

The results from static tests on three bolts and from fatigue tests on bolts with a single nut were taken from a paper contributed to by the authors and published in the June 1952, issue of *Aircraft Engineering*.[4] The bolts used were ¾in diameter, made from steel to B.S.S. S11 (U.T.S. 55/65 tons per square inch). They had hexagonal heads and ¼in B.S.F. machine-cut threads. The radius of the head fillet was $\frac{1}{16}$in instead of the standard 0·03in. The nuts were of mild steel, chosen at random from standard stock. The fitting (Fig. 2) consisted of two hollow mild steel cylinders machined from the solid and held together by the bolt under test. Screwed into the end of each cylinder was an adaptor for mounting the assembly in the testing machine. The latter was a 10±10-ton Avery-Schenck pulsator capable of applying direct mean and alternating loads ; it is illustrated in Fig. 5.

The torque was applied by means of a socket spanner and steel bar and was







Figs. 1 and 2—Thread load distribution diagrams and section through test rig assembly

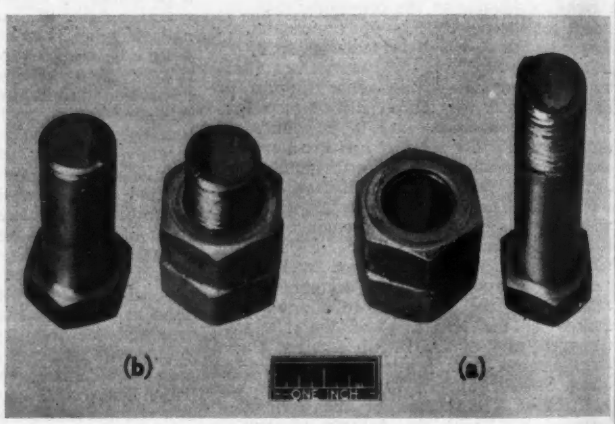


Fig. 3—Bolt failures

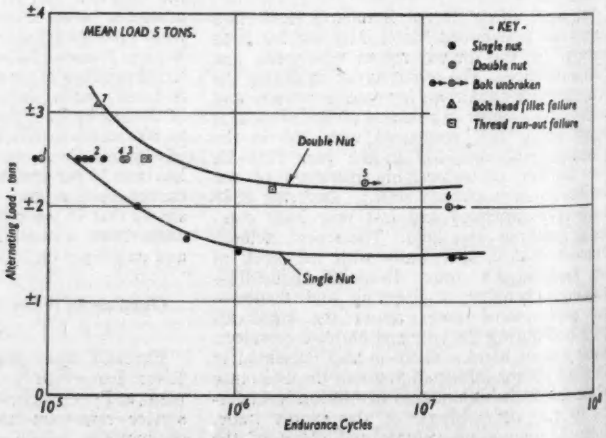


Fig. 4—Single and double nut fatigue tests

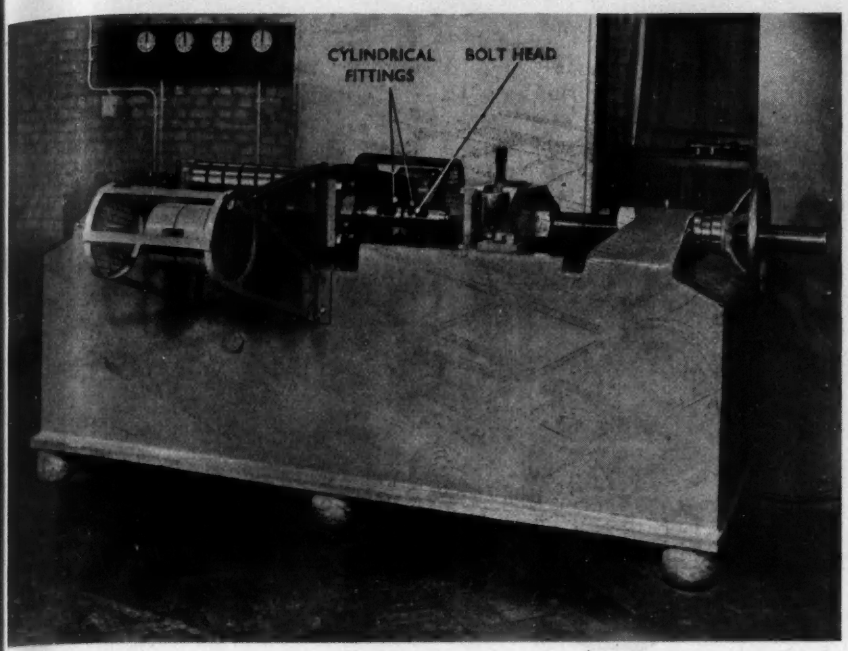


Fig. 5—Fatigue testing machine

measured approximately with the aid of a spring balance connected to the end of the bar. With the inner nut maintained in position by a packing piece the socket spanner applied relative torque to the outer nut. Grease (D.T.D. 577) was applied to the threads and contacting surfaces.

Results of Tests

From the results of the static tests the mean maximum load was 22·25 tons, giving a tensile strength of 63·2 tons per square inch.* The results of the fatigue tests with a single nut are given in Table I.

Table I—*Fatigue Tests on Untightened Bolts (Single Nut) (Mean Load 5 Tons)*

Alternating load, tons	Endurance (millions of cycles)
±2·5	0·143
±2·5	0·084
±2·5	0·199
±2·5	0·143
±2·0	0·295
±1·65	0·554
±1·50	1·020
±1·45	15·0 (unbroken)

The results of the fatigue tests with the double nut, together with values for internut torque, are given in Table II. Fig. 4 shows the results from both groups of tests plotted to a base of endurance.

Table II—*Fatigue Tests on Untightened Bolts (Double Nut) (Mean Load 5 Tons)*

No.	Alternating load (tons)	Endurance (millions of cycles)	Inter-nut torque (lb-ft)
1	±2·5	0·090	0
2	±2·5	0·167	120
3	±2·5	0·257	180
4	±2·5	0·253	180
5	±2·25	5·0 (unbroken)	250
6	2·0	14·14 (unbroken)	250
7	3·06	0·184 (F)	250
8	2·5	0·327 (R—O)	200
9	2·5	0·337 (R—O)	250
10	2·2	1·59 (R—O)	200

F denotes failure in head fillet of bolt.
R—O denotes failure in run-out of thread (thread adjoining shank).

Other failures occurred at the first thread inside the inner face of the inner nut. All failures with the single nut occurred at this section. Fig. 3 reproduces photographs of a bolt failure (*a*) inside the inner nut and (*b*) at the thread adjoining the shank.

* Based on the cross-sectional area corresponding to mean of root and pitch diameters.

Discussion

The failures at the thread run-out and in the bolt head fillet are " non-breaks " when considered in relation to the normal place of failure, viz., near the inner face of the inner nut. The endurance curve given in Fig. 4 for the double nut is drawn above and close to the " non-break " points. Values taken from this curve are therefore low. The limiting alternating load (for non-failure after 10,000,000 cycles) is ±2·2 tons. That for the single-nut is ±1·5 tons. Thus an improvement of ±0·7 ton or 48·5 per cent over the strength of the bolt with a single nut is obtained. The fatigue limit of the bolt is increased from 6·6 per cent to about 10 per cent of the U.T.S. of the bolt.

The distribution of alternating load mentioned in the foregoing suggests a type of laminated nut consisting, for example, of three separate nuts of different lengths graded in order of increasing thickness from the inner to the outer nut.

Conclusion

For a ¾in B.S.F. bolt at a mean load of 5 tons the limiting alternating load (for an " unbroken " endurance of 10,000,000 cycles) is increased from ±1·5 tons to at least ±2·2 tons by using two standard mild steel nuts locked together with an internut torque of 250 lb-ft (approx.).

The authors are indebted to the Chief Scientist, Ministry of Supply, for permission to publish this article.

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[1] Sopwith, D. G., " The Distribution of Load in Screw Threads," *Proc.I.Mech.Eng.*, 1948.
[2] Goodier, J. N., " The Distribution of Load in the Threads of Screws," *Trans.A.S.M.E.*, Vol. 62, 1940.
[3] Hetenyi, M., " A Photoelastic Study of Bolt and Nut Fastenings," *Trans.A.S.M.E.*, Vol. 65, 1943.
[4] Fisher, Cross and Norris, " Pretensioning as a Means of Preventing Fatigue in Bolts," *Aircraft Engineering*, Vol. 24, No. 280, June, 1952.

Commercial Motor Show

No. I

THIS year's Commercial Motor Show at Earl's Court, London, the seventeenth of its kind, is being opened to-day, Friday, September 24th, by Sir Brian H. Robertson, Chairman of the British Transport Commission. The exhibition is the largest of the series which commenced at Olympia in London, in 1907, and the organiser, the Society of Motor Manufacturers and Traders, anticipates that the 1952 paid admission figure of 110,000 will be exceeded on this occasion.

Among the 440 firms represented there are thirty-five British and three Continental manufacturers displaying a great variety of goods and passenger carrying vehicles, ranging from estate cars, taxis and small delivery vans to large lorries and buses. An additional attraction to the show will be a demonstration, jointly organised by the Ministry of Supply and the S.M.M.T., of military vehicles which have been built by the industry in conjunction with the Fighting Vehicle Research and Development Establishment at Chertsey. These vehicles, ranging from 5 cwt four-wheel-drive cargo trucks and tractors up to 60-ton tank transporters, are not to be seen at Earl's Court, and the object of the demonstration is to show that many of these specialised vehicles can be usefully employed for civilian work calling for more than ordinary performance. For this reason the display will be particularly interesting for overseas users operating in circumstances where roads are practically non-existent.

Among the 424 vehicles and countless component exhibits displayed at the show there are obviously those constructions which, since their introduction at one of the two previous post-war commercial motor shows, have been modified in minor details only. On the other hand, a considerable number of entirely new models, partly of very interesting and advanced design, are displayed for the first time.

The general trend of this year's show might be summarised under the heading : greater economy and safety. In the search for increased economy, the industry has resolutely maintained the course, already apparent on the occasion of the 1952 show, of further reducing the vehicle weight and of introducing diesel engines in applications which hitherto have been considered the province of the conventional petrol engine. Practically all manufacturers who still make petrol-engined trucks like the Ford Motor Company, Vauxhall, the British Motor Corporation and others, now offer diesel engines of their own make as alternative power units for light and medium-sized vehicles. In spite of the fact that even the best designed diesel engine is by necessity heavier, more expensive and less flexible in performance than the petrol engine, its low fuel consumption will certainly warrant wider application for operations which entail more than average mileages.

Considerable efforts have been made in recent years to improve the ratio of unladen weight to payload by the construction of lighter chassis and bodies without sacrificing strength. As far as goods vehicles are concerned, the actual savings in weight, mainly achieved by reasonable design and, to a lesser degree, by the use of alloyed steel and light metal, have naturally been less spectacular

than in the case of passenger vehicles. Here the use of integral chassis-body construction has indeed provided substantial weight saving and has given the body builder a design latitude which could not be achieved with the orthodox layout. The bodywork section of the exhibition gives an excellent opportunity of studying the latest examples of integral body design for the two principal systems, the stressed-skin construction and the self-supporting skeleton construction lined with light panels, are well represented. Also of interest are several well-designed examples of light-metal cabs for goods vehicles.

In this connection it might be added that the possibility of weight saving by the installation of smaller engines with low torque and, consequently, a multiplicity of gear ratios is still in its infancy. Most users seem to be opposed to this scheme as well as to the employment of two-stroke and supercharged power units with their promise of economy in weight and cost. Whether or not this attitude is likely to persist will to a great extent depend on the road performance of the numerous new engines incorporating these principles which are now making their first appearance at the show.

One particular aspect of design which has rightly received special attention from manufacturers is the comfort of the driver, on whom the safety of persons and property depends. This applies as much to the actual seating comfort as to the provision of such items as heaters, demisters and defrosters.

Much thought and work has been devoted to reduce the physical effort of driving, in particular to facilitate gear changing in city buses, the ultimate aim being the elimination of the clutch pedal. Several passenger vehicles at the show are fitted with semi-automatic epicyclic gearboxes, which enable gear changes to be made without using any clutch pedal solely by moving a small lever under the steering wheel. Mention should also be made of the various systems of power-assisted steering which can be seen on several heavy vehicles.

The following paragraphs cover a selection of vehicles of new or improved design in order to give a general impression of the size and scope of the show and to illustrate the present trend of development. In view of the diversity and great number of exhibits, it is impossible to describe such new vehicles as the small delivery vans of Austin, Ford, and Morris, or any of the latest additions to the already well-established makes of estate cars and taxis, all vehicles which are, in fact, sister products of their namesakes in the car range, sharing many of their assemblies and components.

The A.C.V. group of companies, comprising the firms of A.E.C., Crossley and Maudslay, shows various types of vehicles for home and overseas markets. In the goods range the 8-ton payload "Mercury" with a versatile range of alternative engines and wheel bases, is a new design; two specialised vehicles are also making their first appearance, a 6×6 tractor (Fig. 2), specially developed for arduous cross-country military duties, and a similar, but less rugged model, the 4×4 "Matador," designed for heavy duty on or off the road. The passenger range includes single-decker buses with the now universally acclaimed underfloor engines, the latest additions to the series being the lightweight "Monocoach" and "Reliance" vehicles. Also on view is the new "R.T. 12" lightweight double-decker, recently developed by A.E.C. after months of intensive research in conjunction with London Transport Executive.

The "Mercury" goods chassis is designed to carry an 8-ton load within a legal gross weight of 12 tons, to give a top speed exceeding 40 m.p.h., and the ability to surmount gradients of up to 1 in 4½. Two sizes of A.E.C. vertical six-cylinder direct injection engines can be fitted; a 6¾-litre engine, with 105mm bore by 130mm stroke, developing 98 b.h.p. at 2000 r.p.m., and a 7¼-litre engine with 112mm bore and 130mm stroke, with an output of 112 b.h.p. at 2000 r.p.m.

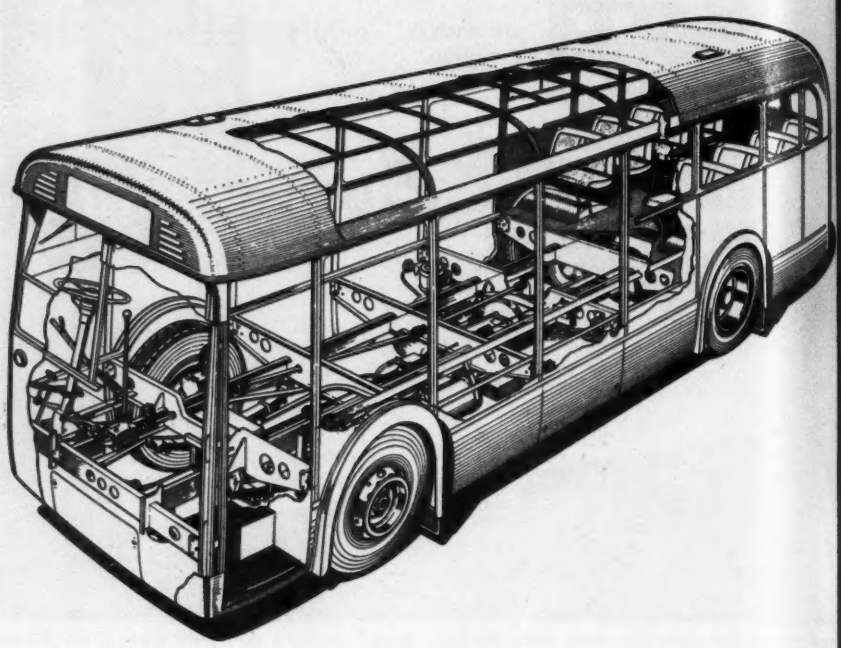


Fig. 1—"Monocoach" with a horizontal, 6-cylinder direct-injection oil engine of 470 cubic inches capacity

The chassis is available with right or left-hand control. Nominal "ready for the road" weight for the 13ft 6in wheel base chassis is 3 tons 7 cwt. A choice of three wheel bases for normal use and one wheel base for tractor use is offered.

The chassis frame is built up from channel-section side members with channel-section cross members. Four semi-elliptic leaf springs are used, anchored at the ends to the spring brackets by shackle pins, with telescopic hydraulic dampers, fixed to the front axle, and helper springs to the rear axle.

The engine torque is transmitted through a single dry plate clutch to a five-speed inertia lock synchromesh gearbox, all gears of which, with the exception of first and reverse gears, are fully synchronised. The selector mechanism is carried in a cover which can be removed from the gearbox as a complete unit. The gear lever is mounted in an oil-tight casing attached to the rear of the engine casing and operates the gearbox selectors by way of a short tube.

The propeller shafts are of open tubular construction fitted with Hardy Spicer needle-bearing universal joints. The 13ft 6in and 16ft 3in wheel base chassis, which use two-piece propeller shafts, have a self-aligning intermediate bearing.

The spiral bevel rear axle has fully floating axle shafts and the drive to the wheel hubs is transmitted by an integral flange. This is bolted to the wheel hub, which runs on taper roller bearings on the axle casing; the driving torque only is taken by the axle shafts.

The steering gear is of the worm and nut type, and, to take vertical thrust, the upper end of the steering shaft is located in a self-aligning ball bearing; this bearing is mounted between rubber rings, which absorb shock and permit the slight rocking action of the steering shaft caused by the bronze nut passing through an arc during its movement.

Two kinds of braking system are available, either vacuum-hydraulic or compressed air. In the former case the main servo motor is mounted outside the frame side member and assists the driver's braking effort, being coupled by hydraulic means to the brakes on all four wheels. With the air pressure braking system a two-cylinder compressor takes the place of the exhauster. A single-chamber Clayton Dewandre air reservoir with unloader valve is mounted on the frame side member whilst the brake valve is mounted on the driver's floor plate.

Both front and rear brake cylinders are mounted on their respective axles. Girling two-leading-shoe wedge-operated brakes are fitted to the front and rear of chassis with the vacuum-hydraulic system, whilst chassis with the air pressure system have Girling cam-operated brakes with both leading and trailing shoes.

Reference is made on page 415 to the new lightweight double-decker bus developed in conjunction with the London Transport Executive. This vehicle, which is to replace the trolleybus on London routes, is a sixty-four-seater bus of monocoque construction, 27ft long and 8ft wide, with an estimated laden weight of only 11 tons. The vehicle is an excellent example of what can be achieved by close collaboration between manufacturers and operators of large public transport organisations. The design, with its integral body structure, the extensive use of light alloys, independent front suspension, and ingenious coil spring rear suspension, is sufficiently interesting to warrant the more detailed review which is being given in a separate article in this issue.

In response to the widespread demand for a lightweight model capable of undertaking consistently heavy-duty service, the A.C.V. Group has introduced two new types of single-deck, underfloor-engined vehicles, both offering a high standard of passenger comfort.

The "Monocoach" (Fig. 1) is of integral construction and special features developed in conjunction with Park Royal Vehicles, Ltd., have enabled the fully laden weight of this

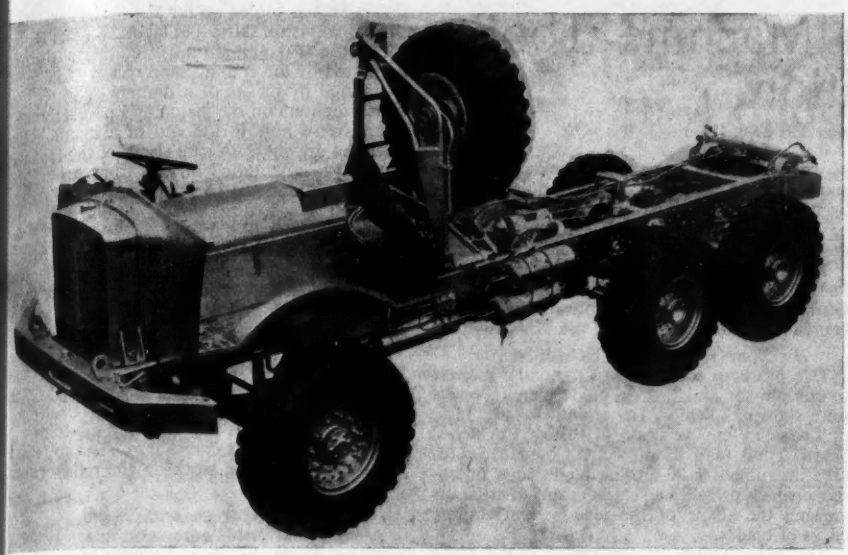


Fig. 2—Chassis with an 11·3-litre direct injection oil engine, a five-speed gearbox, and two ratio auxiliary gearbox distributing drive to front and rear axles

vehicle to be reduced to less than 8 tons 10 cwt. The "Reliance" has a normal frame for conventional body mounting, the complete chassis weight being under 3 tons 14 cwt, and the maximum gross vehicle weight 9 tons 10 cwt.

The "Monocoach" has no separate body or chassis, the shell being of stressed-skin construction with the side structure forming the main longitudinal beams supporting the vehicle. The shell, including the underframe unit, is fabricated from sub-assemblies, jig-built to ensure complete interchangeability. The steel underframe includes eight deep, but light, transverse members which are rigidly attached at their outer ends to the vertical pillars; two full-length longitudinals pass through the transverse members and are welded at their intersections.

To achieve lightness with strength, light alloys are intensively used in the shell structure and panels. Flanged box-section extruded aluminium vertical pillars are directly attached to the underframe cross members and interior alloy trussing extends from floor to waist. The extruded waist rail of special section provides easy attachment for truss panels and exterior panelling. Deep section alloy cant rails and double-skin roof framing are also used. Other details include alloy window pans, extruded seat rails, and angle crib rails supporting the ply floor.

Apart from the difference in the construction of the frame, the "Reliance" and the "Monocoach" are basically similar in their mechanical layout. The engine, resiliently mounted at three points, is located almost centrally in the vehicle frame. There are two alternative types of transmission, either a five-speed synchromesh gearbox with hydraulically operated dry plate clutch, or a four-speed air-operated epicyclic gearbox with automatic centrifugal clutch.

A single propeller shaft, with universal joints, couples the gearbox to the spiral bevel rear axle. This axle has a pressed steel casing, the driving shafts, which are of equal length, being flanged directly to the wheel hubs, which are mounted on taper roller bearings.

Two types of braking system are available—triple servo vacuum or compressed air, with the synchromesh gearbox or compressed air with the epicyclic gearbox.

The most powerful vehicle at the stand of Leyland Motors, Ltd., is the six-wheeled, left-hand drive "Super Hippo" chassis (Fig. 3), which is designed for the export market, but denied to the home operator by restrictive transport regulations. This robust load carrier is shown with a supercharged Leyland 9·8-litre engine which develops 185 b.h.p. at 2000 r.p.m., and it is equipped with power-assisted cam-and-double-roller steering.

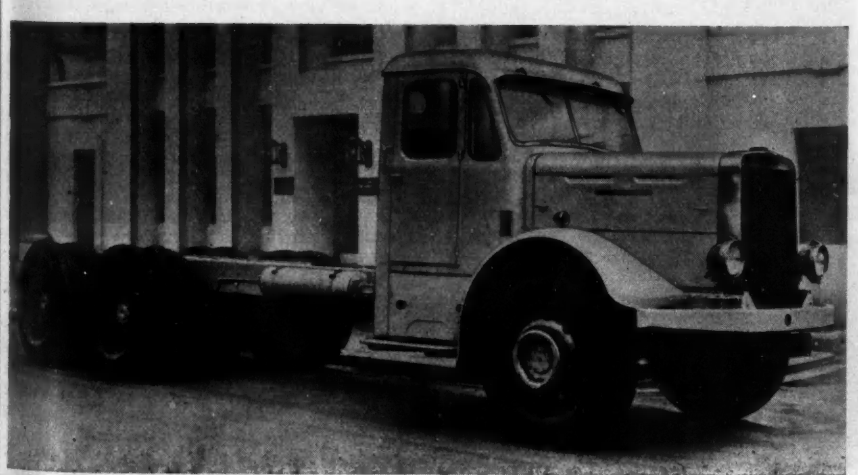


Fig. 3—"Super Hippo" chassis with redesigned cab and 185 h.p. supercharged diesel engine

The six-cylinder o.h.v. diesel engine has a bore and stroke of 4·8in by 5·5in and is fitted with a Leyland-built supercharger, consisting of a radial-flow compressor driven by an exhaust turbine. Engine, clutch and gearbox are of unit construction, carried in the frame by a flexible mounting at the front end and by a banjo type cross member at the rear, rigidly attached to the frame side members. The clutch is of the single dry-plate kind with a flexible centre. The five-speed, constant-mesh gearbox has helical gears in the third and fourth speed to promote quietness in operation.

The two rear driving axles, fitted in the form of a bogie, are of identical construction, and are equipped with improved overhead worm drives. Cam-operated brakes are fitted, actuated by air pressure supplied by a two-cylinder compressor. The inverted semi-elliptic rear springs are secured at their centres to a spring chain mounted on the trunnion bearings, the outer ends of the springs being attached to the rear axles by swivelling trunnions. The frame is of pressed channel-section steel; the overall dimensions of the show model are 29ft by 7ft 11½in with 17ft 9in wheel base, and its gross rating is 47,600 lb. Mounted on this chassis is the new Leyland insulated cab. This is basically similar to the double-skin cab with which the "Super" range has hitherto been fitted, but it has been modified to accommodate the near-vertical steering column introduced to give improved forward visibility. Fresh air for the heater and ventilator unit is taken in through two grilles, one in each front corner panel.

(*To be continued*)

Short Notices

Optical Instrumentation. Edited by G. S. Monk and W. H. McCorkle. London: McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 30s.—This book contains selected reports of a specialised optical subject and does not constitute a general handbook. The book itself says: "Most of the problems considered arise from the need for visual observation of areas that must be shut off from the observer by heavy shields." With this central theme, certain aspects of theoretical optics are presented, followed by more detailed reports on the design and construction of instruments to meet defined problems. In some cases the construction has been influenced by the effects of irradiation damage and alternative plastic materials and metal mirror systems have been used. A study group interested in remote control with assisted vision should certainly know of the work carried out and so admirably reported in detail.

Manual of British Water Supply Practice. Second edition. Edited by A. T. Hobbs. Cambridge: W. Heffer and Sons, Ltd. Price 55s.—The first edition of this work, which is an authoritative and comprehensive survey of British water supply practice prepared by various committees of the Institution of Water Engineers, was reviewed in our issue of March 23, 1951. The contents have been revised and brought up to date in this edition, and a new chapter on the economics of water engineering has been added.

Significance of Properties of Petroleum Products. Edited by George Sell, F.Inst.Pet. London: The Institute of Petroleum, 26, Portland Place, W.1. Price 7s. 6d.—The book should help to interpret the results obtained from standard tests laid down by the Institute of Petroleum in this country, and the American Society of Testing Materials in the U.S.A. It consists of revised reprints of articles from the 1949–50 pages of the *I.P. Review*, and gives numerical references to the standard tests published annually by I.P. and A.S.M.T.

Fourth European Machine Tool Exhibition

No. III—(*Continued from page 386, Sept. 17th*)

Newall Engineering Company, Ltd.

THE representative group of machines which were displayed by the Newall Engineering Company, Ltd., Peterborough, included one of the firm's improved "Model 2436" jig borers. This machine has a 24in by 36in table with a longitudinal traverse of 24in and a cross traverse of 18in, and has the now familiar roller system of table location.

The column of the machine has been redesigned to give increased rigidity, and the spindle gearbox now has three speeds through a steplessly variable a.c. drive giving spindle speeds from 40 to 2500 r.p.m. In a redesigned head assembly both the spindle and quill are made of hardened and ground nitralloy steel, and the spindle runs in S.K.F. preloaded, double-row roller bearings with oil mist lubrication. The quill has a vertical feed of 9in and its head has an adjustment of 14in on the column, to enable a maximum setting distance of 32in from the spindle nose to the table. Three spindle feeds of 0·001in, 0·002in and 0·010in per spindle revolution are available.

The two model "L" and "LA" cylindrical grinding machines shown are fitted with the recently introduced unified hydraulic control box which allows additional hydraulic equipment to be installed without difficulty.

Mannaioni Works

A precision, high-speed production screw-cutting machine with an automatic cycle which is made by the Mannaioni Works, 54–56, via Capo di Mondo, Florence, Italy, is illustrated in Fig. 18. This machine takes work up to 28in long between centres and it can be used to thread work 6½in diameter over the saddle and 12in diameter over the bed, and up to 18in long.

The bed and headstock of the machine are made as a single casting to ensure rigidity when working at high speeds, and the saddle slides on hardened and ground steel ways fixed to the bed. The main top rear bed way is steeply inclined towards the rear. Drive from the 6 h.p. motor is transmitted through vee belts to the headstock, in which a single lever is used to operate a multi-plate friction transmission clutch and a brake. A second clutch lever controls the gears driving the leadscrew and a third lever controls the direction of spindle rotation. The spindle is carried on roller bearings, and its speed is adjustable over a range from 500 to 2000 r.p.m. Leadscrews are selected in accordance with the required thread and can easily be removed by loosening three clamping screws. The lead-screw drive, reverse and rapid traverse mechanism is designed to withdraw the screwcutting tool and reposition it at very high speeds.

The saddle contains all the automatic control mechanism for setting the depth of cut, number of cuts, and stopping the machine at the end of its working cycle. Its working stroke, in accordance with the length of thread required, is set by adjustable stops. Taper screw threads can be cut by fitting a copy plate in the apron of the saddle and engaging a follower.

These screwcutting machines are distributed in the United Kingdom by the Elgar Machine Tool Company, Ltd., Hampton Road West, Hanworth, Middlesex.

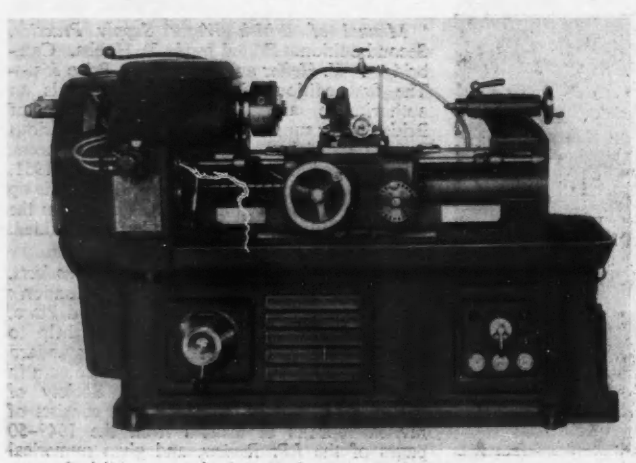


Fig. 18—High-speed screw-cutting machine

Taylor, Taylor and Hobson, Ltd.

Two pieces of equipment of particular interest to compressor and turbine blade manufacturers were shown by Taylor, Taylor and Hobson, Ltd., of Leicester, on the stand of British Engineers' Small Tools and Equipment Company, Ltd. One instrument is a turbine blade edge microscope which provides a simple means of critically viewing the shape of the leading and trailing edges of blades.

The second piece of equipment is the blade projector, which is illustrated in Fig. 19, and is

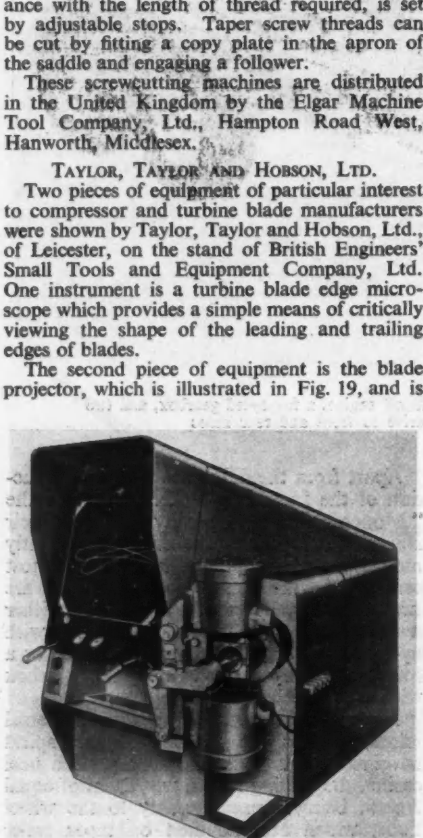


Fig. 19—Taylor-Hobson projector for inspecting compressor and turbine blades

designed to project sections of shrouded or unshrouded blades up to a width of 2½in and sections along the blade up to 8in from the tip. In this instrument the required section is delineated by a line formed round the blade either by projection from a slit or by marking with white paint, and an image of this line is projected on the screen at ×10 magnification by a wide aperture lens. By means of a mirror system it is possible to project two sections simultaneously, the images being compared with a master outline carried on the screen.

All measurements are taken relative to the root of the blade and displacement errors are noted on conveniently situated dial indicators reading in thousandths of an inch. The screen is movable in the lateral and vertical planes by means of a joystick, so that the master outline can be brought into line with the projected images. Errors of twist are measured by rotating the blade about its axis by a micrometer graduated in minutes of arc.

John Lund, Ltd.

One of the fine boring and facing machines made by John Lund, Ltd., Cross Hills, Keighley, is shown tooled up for the oval taper finish turning of piston skirts and lands. In this set-up the piston is mounted on a fixed arbor where it is located by the end face and recess. Clamping is effected by means of a dummy gudgeon pin, which registers on the piston and passes through a transverse hole in the end of a hydraulically operated drawbar. A cam sleeve of the required taper oval is mounted on the arbor behind the work piece, and the tools are carried by rocker arms on the fixture which travels along the machine bed.

The front rocker arm of the fixture carries a guide finger, which registers on the cam sleeve, and also the skirt turning tool. This rocker arm is mounted on needle roller bearings and is spring loaded to hold the guide finger in contact with the cam sleeve during turning. The rear rocker arm, which carries the roughing and finishing turning tools for the lands of the piston, is fed into the work and retracted by hydraulic means. A link coupling the front and the rear rocker arms comes into effect to retract all tools clear of the work on the return stroke of the fixture table.

Jos. Koepfer and Sohne

A new universal automatic gear hobbing machine made by Jos. Koepfer and Sohne, Furtwangen, Germany (represented by the Adam Machine Equipment Company, Ltd., 4, Grange Street, St. Albans, Herts), is illustrated in Fig. 20. It is of travelling workhead design and is particularly intended for the production of gears up to 4½in diameter by 4½in face. The machine exhibited is arranged for magazine feed and works on an automatic cycle.

The machine has nine hob speeds from 100 r.p.m. to 1000 r.p.m. and nine feed rates from 0·0016in to 0·064in per revolution of the work.

Fig. 20—Universal automatic gear hobbing machine equipped for magazine loading of blanks

It can be used for either down-cut or conventional hobbing and can be arranged for cutting worm wheels. When hobbing helical gears and worms a differential is fitted to the feed drive.

In the automatic cycle the hob moves up to the blank and longitudinal feed begins; at the end of the feed movement the hob spindle head moves down clear of the work and the workhead returns quickly to its starting position. The finished gear is then ejected and a new blank automatically inserted ready for the next cutting cycle.

Churchill-Redman, Ltd.

Three sizes of hydraulic copying lathes are now made by Churchill-Redman, Ltd., of Halifax, and the intermediate 12in by 40in machine was exhibited at Milan. This machine swings 6in over the top slide and 16in over the saddle, and is of generally similar design to the two other 14in by 60in and 12in by 20in lathes made by the firm.

The lathe, which is illustrated in Fig. 21, can be supplied with a single-speed motor giving eighteen spindle speeds from 260 r.p.m. to 1760 r.p.m., or a two-speed motor gives thirty-six

speeds from 130 r.p.m. to 1760 r.p.m. The spindle is mounted on Timken roller bearings and is controlled through a hydraulically operated clutch and brake. The three-jaw self-compensated chuck is fitted with a spring-loaded centre, and the hydraulically operated tailstock is actuated by the same pedal as the chucking cylinder. This arrangement ensures that a component is pushed against the spring centre and secured by the chuck jaws whilst the tailstock ram is locked.

A 45 deg. tool slide, carrying a top slide with the tool holder and sizing stops, is mounted on the saddle, which has an infinitely variable hydraulic feed up to 17in per minute. When required, a hydraulically operated rear tool slide can be fitted for facing, undercutting or grooving tools, and this slide can be arranged to come into operation automatically.

Up to four cuts can be taken on a work piece where it is required to remove a large amount of material, only one template being required to control tool movement on the final cut. When setting up the machine for automatic operation it is only necessary to set dogs on a four-position trip bar on the front of the bed to control the longitudinal traverse at each cut, and four dogs associated with the tracer valve control, to determine the diametral settings of the tool.

When operating with the automatic control the work piece is placed in the loading cradle, and depression of a foot valve causes the tailstock barrel to move forward hydraulically to engage the work, which is then gripped automatically. The operator moves a starting lever to engage the spindle drive, whereupon the coolant starts to flow, the tool is fed into depth for the first cut, and the carriage feed is engaged. At the end of the cut the carriage is automatically returned towards the tailstock under rapid traverse, the two trip bars are hydraulically indexed to the next position, and the feed is re-engaged. When the required number of cuts has been taken the machine is automatically stopped with the carriage returned to the tailstock end of the bed, and the trip bars reset for the first cycle. The machine can be stopped completely at any time during a cycle by movement of the starting lever in the opposite direction. The tool is then retracted and the carriage returned to the starting position. Release of the work piece for unloading is effected by simply depressing a pedal.

If the machine is fitted with a two-speed driving motor it is possible to select either of two spindle speeds, in the ratio of 2 to 1, for any of the four cycles, the speed change being automatically effected by the control drum on the front trip bar. Provision is also made for automatically changing the feed rate of the carriage, during the course of any cycle, and at any point in the carriage travel.

(To be continued)

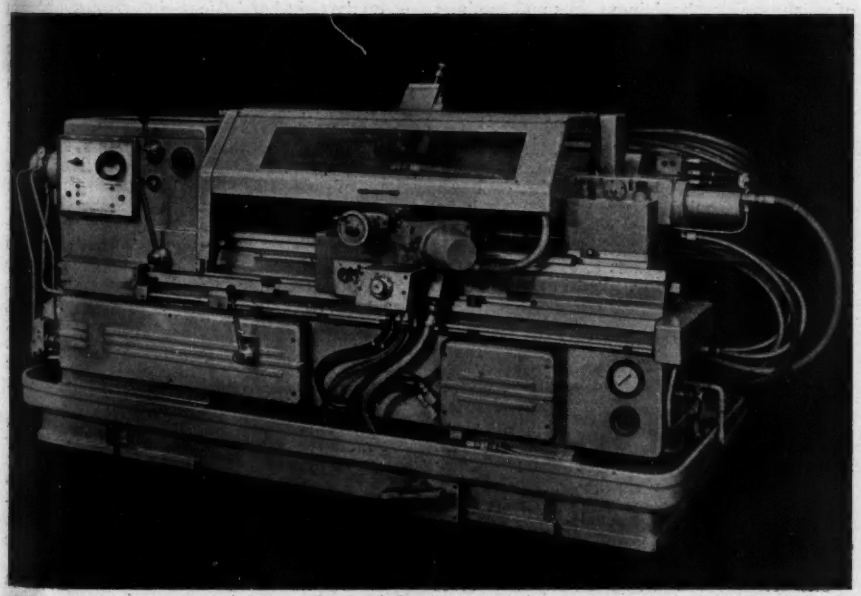


Fig. 21—Automatic 12in by 40in hydraulic profiling lathe with multi-cut control

Sixty-Four Seat Double-Decker Bus for London Transport

The London Transport Executive recently set itself the task of providing an all-metal, two-axled, double-deck bus replacement for the existing seventy-seater, three-axled trolleybuses. It had to seat sixty-four passengers within a loaded weight not greater than that of the present fifty-six seater vehicle. The very advanced vehicle which was evolved is described below. It has a light alloy monocoque body structure with easily removable front and rear sub-frames on which the engine and most mechanical components are mounted. The front suspension is independent and it has a new form of coil spring rear suspension and stabilising arrangement.

A NEW double-decker bus which, as can be seen from our drawings, departs in many ways from conventional automobile practice in this country, has been designed by the road vehicle engineers of London Transport, led by Mr. A. A. M. Durant, the chief mechanical engineer. It is a two-axle vehicle seating sixty-four passengers and will replace the seventy-seater, three-axle trolleybuses. Its design aimed at a loaded weight no greater than the present fifty-six-seater bus. A prototype of the new vehicle, further developed and constructed in association with A.E.C., Ltd., and Park Royal Vehicles, Ltd., is being shown at the Commercial Motor Show, and some further comment on this vehicle appears on page 412.

Design

The vehicle has a monocoque structure seeking maximum seating capacity for minimum weight, the arrangement of the mechanical units giving ease of control and ease of servicing and overhaul. It is 27ft long and 8ft wide, with a wheelbase of 16ft 9in. To achieve an estimated laden weight of 11 tons, general savings in weight in both body structure and mechanical units have been necessary. They have been effected in the body structure by the use of light alloys, fibreglass and other weight-saving materials, with the result that the estimated unladen kerb weight is 6 tons 17 cwt 2 qrs, inclusive of fuel, oil, water, &c.

No conventional chassis frame is employed, the body structure serving as the main load-carrying unit, with small sub-frames to mount the mechanical units at front and rear, these being so arranged as to be easily removable for overhaul. Independent front suspension and a patented form of coil spring rear suspension are used to give a wide roll centre which promotes vehicle stability coupled with much improved riding characteristics. The engine mounting prevents the transmission of vibration to the body structure. In the interests of driving efficiency the gear selector pedal has been eliminated, direct engagement of gears being by electro-hydraulic means controlled by a column-mounted gear shift lever. The hand-brake lever is positioned to the left of the driving position to facilitate entry to the cab, and much improved ventilation, heating and demisting is provided.

Body Structure

The four-bay vehicle structure consists of a rigid box formed by the underframe, sides, roof and front and rear bulkheads, and is fabricated from high-duty aluminium alloy throughout. The front bulkhead carries the driver's cab and front nearside units such as the wing, bonnet, and front cowling, while the rear platform structure, staircase, &c., are suspended from the upper saloon. Attention has been paid to the need for ease of repair and replacement of front and rear end body parts, and to the removal of running units for overhaul and maintenance, a necessary consideration to conform with routine maintenance.

The underframe consists of rigid cross members of great depth, each completely fabricated from high-duty aluminium alloy, in the form of an "I" beam. Bolted to the end of each are the lower saloon side pillars, the connection being made with angle members between the "H" section pillar and the cross member. The lower saloon body side is made of the "H" section extruded alloy pillars with sheet stress panels from waist to skirt solid riveted to the inside flange of the pillar and bolted between the cross bearer and pillar. The waist rail and cant rail are a simple channel riveted to the pillars in bay lengths providing anchorage for the panelling and window pans. Exterior panelling of aluminium sheet is butt-jointed and blind riveted to the framing without vertical cover strips, the stress panelling being fitted internally to minimise replacement difficulties in the event of accident damage.

Floor bearers for the intermediate roof are of similar form to the main cross members, though not so deep, and extend from pillar to pillar, and form the anchorage of the upper saloon pillars, which are again of extruded alloy in "H" form, but of lighter section than those in the lower deck. The stress panels of the upper saloon are fitted externally, not being subject to much damage, and also butt-jointed without vertical cover strips, and an interior trim panel of sheet aluminium is solid riveted to the framing. The waist and cant rail are again of simple channel section, and a similar member is fitted at intermediate floor level for securing the base of the upper saloon stress panel and the panel over the lower saloon windows.

The upper roof structure is of square-section alloy tube, with riveted overlapped exterior panelling in alloy sheet, in bay lengths from front to rear, and with aluminium sheet front and rear domes. The floors and ceilings are made entirely from alloy sheeting; in corrugated form this performs the load-carrying functions and in sheet form provides ceilings, floor coverings, and, in the case of the lower deck floor, an easily cleaned underside of the body. On both decks the ceiling panels extend from cant rail to cant rail in bay lengths, the pillar pitch being 4ft 1½in centres. The divisions between sections of sheet flooring occur at the longitudinals on either side of the gangway. An interesting detail of the upper deck floor is that the sheeting is laid in three

flats instead of the orthodox radius. Floor cove panels of chequered aluminium plate are fitted to both decks.

The rear wheelboxes and footstools are fabricated in sheet alloy and are particularly rigid, since they form beams for the support of the rear suspension unit, and house the two rear coil springs and shock absorbers. These are built into the rear bulkhead which is in alloy sheet extending up to and tied in with the intermediate floor. The rear platform framing is suspended from the upper saloon rear end, and the platform floor is alloy framed and covered with alloy sheet, suitably stiffened. The rear end framing, extending round the rear quarter and up to cant level, is designed to be easily removable in the event of damage, and to facilitate working on the rear end; the staircase—similar in shape to those of existing London vehicles—is split at the fourth tread and the lower portion is easily removable.

The front bulkhead, having a continuous channel member from side to side above the flywheel arch, has a skin of aluminium alloy on the forward face to which are riveted the channels and angles forming the bulkhead proper. Two buttresses are built on to the front face of the bulkhead on each side of the flywheel arch to form the anchorage for the vertically positioned front sub-frame attachment bolts, and are so designed as to spread the load evenly on to the bulkhead. The rear anchorages of the front sub-frame are built in to the ends of the front main cross bearer and the bodyside, to carry the horizontally disposed attachment bolts, and additional alloy sheet trussing extends forward to the bulkhead and back to the second bearer, to spread the load over a larger area.

Jacking Points.—For lifting the vehicle during removal of the running units, lifting and jacking points are provided adjacent to the front and rear bulkheads. The front lifting points are incorporated in the driver's recessed step and a similar step in the nearside with locating pegs positioned beneath the skirt to support the body on jacks. Similar pegs are fitted adjacent to the rear bulkhead with appropriate lifting recesses.

Cab, Bonnet and Other Details.—The driver's cab, in which special attention has been given to the siting and disposition of all controls, is generally similar to the current London vehicles and is cantilevered off the bulkhead, being removable in sections to facilitate repair and replacement. The fibreglass bonnet top is hinged to the front bulkhead on the nearside of the cab, and is spring balanced. The enveloping form of front nearside wing is suspended from the bulkhead on flexible bushes, having the radiator header tank and filler housed within, also mounted on the bulkhead. Fibreglass is used for the wing valances. The frontal grille and front end shaped panelling, in sheet aluminium, carries the usual lamp equipment, and has a small hinged panel for access to the oil filler, dipstick and fuel cock. The centre front panel and a section of the nearside wing are removable for access to the engine.

The cab is fitted with a heater and demister, both of which supply cold or warmed fresh air, with safety switching to cut the fan if the fresh air control is closed, thus preventing recirculation of air already heated within the enclosed space of the cab.

The gangway floor and platform are covered with a rubber/cork composition ; bevelled slats and tiles of the same material are cemented down between and beneath the seats. The spaces between the slats facilitate floor cleaning.

The main saloon windows are inside rubber glazed in alloy pans having polished interior rims, beneath which the flat inside finishers are inserted. Four opening side windows in the lower saloon and six in the upper are of alloy framed high-level winder design with no bottom rail to the moving portion. These are designed to facilitate cleaning. The forward facing opening windows are provided with a locking mechanism to prevent opening in cold weather. Two of the fixed glasses in each saloon are breakable for emergency use, whilst an alloy frame of pressed sections with curved toughened glass forms the rear emergency exit in the upper deck. Two adjustable intake vents are provided in each saloon front framing.

Seating.—The seating capacity provides for twenty-eight seats in the lower and thirty-six in the upper saloon on tubular seat frames. The squab backs are fabricated from fibreglass, and the cushion and squab fillings, in the interests of lightness, are of foamed plastic. The seat and squab trimming is in moquette with hide ends, with leathercloth trim to the squab back.

Electrical Equipment.—Four 6V batteries are carried in a cradle under the stairs. This cradle is in light alloy and permits removal of batteries from outside, but topping up is carried out from a hinged flap under the stairs. Winking direction indicators of arrow form are fitted at cant level at the front of the body, hinged to prevent accidental damage, and these are electrically linked to arrow lamps in the rear panels at waist level. The saloon lamps have special fittings allowing each to be mounted to the ceiling panels from the saloon side, since no detachable lighting cove panels are provided. In the interests of weight saving, aluminium cables and conduits are largely used. Three destination indicators are provided, all of lightweight construction and operable from within.

Sixty-four-seat double-decker bus for London Transport

Livery and Trim.—The interior colour scheme is a departure from current practice. The seat trimming is a patterned moquette toning with the interior finishing colour of damask red and ceiling panels of sung yellow. The squab backs are trimmed in Chinese green leathercloth. A polished alloy moulding separates the two colours and has a white plastic insert in the centre. Platform and staircase stanchions and handrails together with their brackets and fittings, are of stainless steel, while those fitted in both saloons are of polished alloy.

Mechanical Units

Front Sub-Frame.—The engine, steering and front suspension are carried on a sub-frame which consists mainly of two pressed channel-section longitudinal members. They extend forward from the front bulkhead and are attached at four points, two at No. 2 cross bearer and two at buttresses built on to the front bulkhead. In plan the members converge towards the front, being anchored to the main body sides at No. 2 cross bearer and reduced to normal chassis width at the front.

The longitudinals are joined by two cross members ; a substantial fabricated box-section member under the centre of the engine carries the main engine mountings, and the mountings of the independent front suspension units, whilst a channel-section member joins the front ends of the longitudinals and supports the front of the engine.

At each of the four body attachment points, a large pin or bolt forms the main attachment, with a shallow double conical packing interposed in seatings between the two connected assemblies for location purposes. The two pins at the front bulkhead are carried vertically, while those at the rear are horizontal.

In order to remove the front running unit assembly, or "horse," the propeller shaft, controls, fuel and brake lines, &c., are disconnected and the pins of the front attachment points are removed. The main vehicle structure is then lifted and the front running gear unit hinges down about the rear attachment points until the steering column has cleared the cab floor. The two rear attachment points are then disconnected and the running unit wheeled forward on the two front wheels.

Engine.—The engine is the A.E.C. 9·6 litre direct-injection unit developing 125 b.h.p. at 1800 r.p.m., which because of the absence of a conventional frame and leaf springs can be mounted offset towards the left-hand side. The engine is slightly modified to suit the special requirements of the vehicle, but is basically the same as the unit used in existing London Transport vehicles.

The main engine mounting is approximately at the centre of the engine and consists of two rubber sandwich units positioned to form a vee about the longitudinal axis of the engine and attached to facings on the crankcase bottom half. A third mounting point is in the form of a large circular rubber unit on the front of the cylinder block and carried on the front cross member, following current A.E.C. practice.

A 7in diameter high-speed dynamo is mounted on the right-hand side of the crankcase bottom half and driven by quadruple vee belts from a pulley on the front of the crankshaft. The dynamo has a specially extended armature shaft to take a coupling for the drive to the fan and water pump.

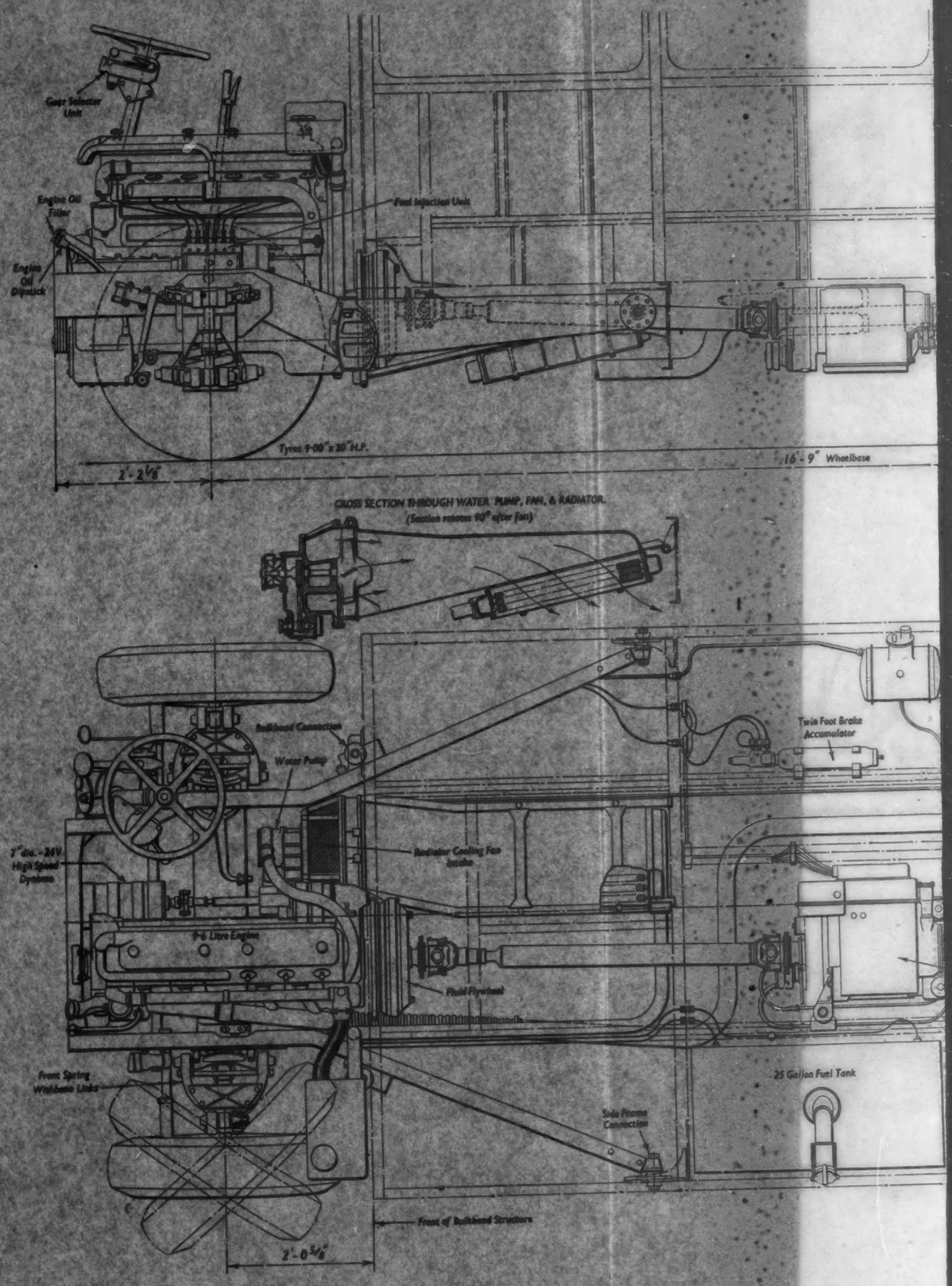
The water pump and fan are mounted as a sub-unit with the radiator, which has an almost horizontal position under the main floor to the right of and behind the engine. The whole sub-unit is readily detachable from the main structure on which it is carried by three flexible mountings. The water pump and fan are mounted vertically, together with a duplex chain drive carried in an oil bath casing and driven by a jackshaft from the rear of the dynamo. Ducting is provided between the fan and the radiator, and a condensing header tank is fitted on the body front bulkhead on the left-hand side with the filler accessible through a trap in the wing.

The oil filler, dipstick and fuel shut-off cock are mounted at the front of the engine for easy access through a trap in the front valance.

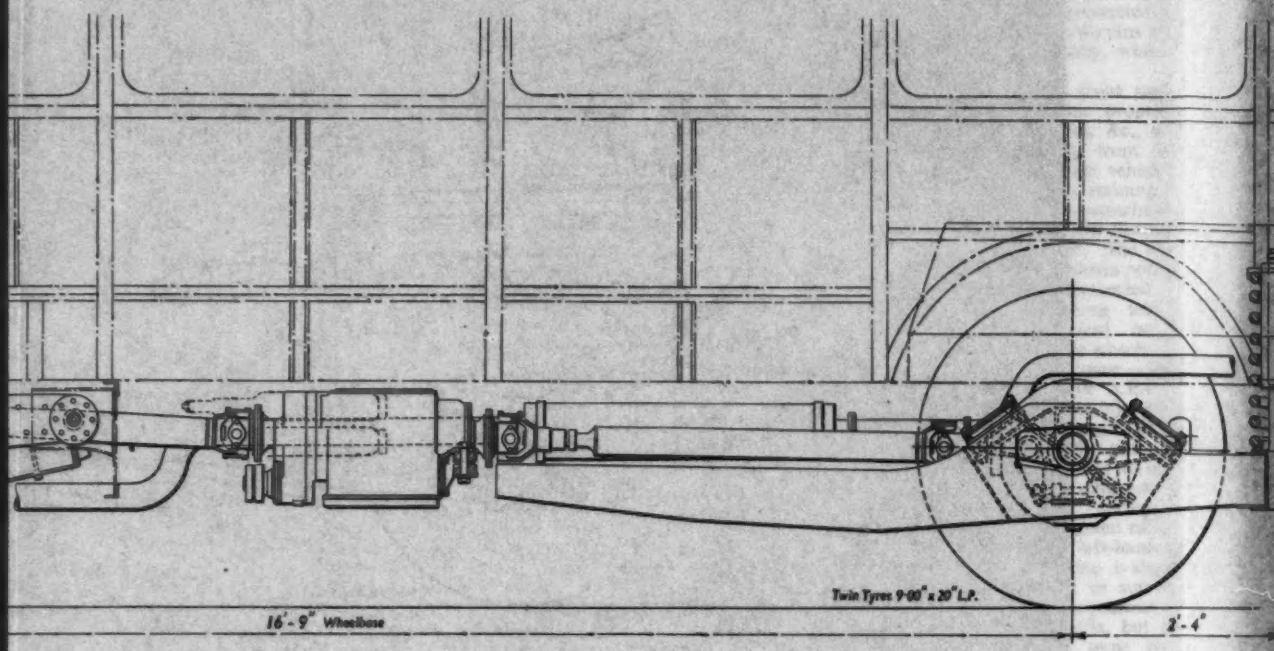
The main oil sump is at the front of the crankcase bottom half and a scavenge pump is incorporated with the main pressure oil pump to return oil from the small rear sump well to the main sump.

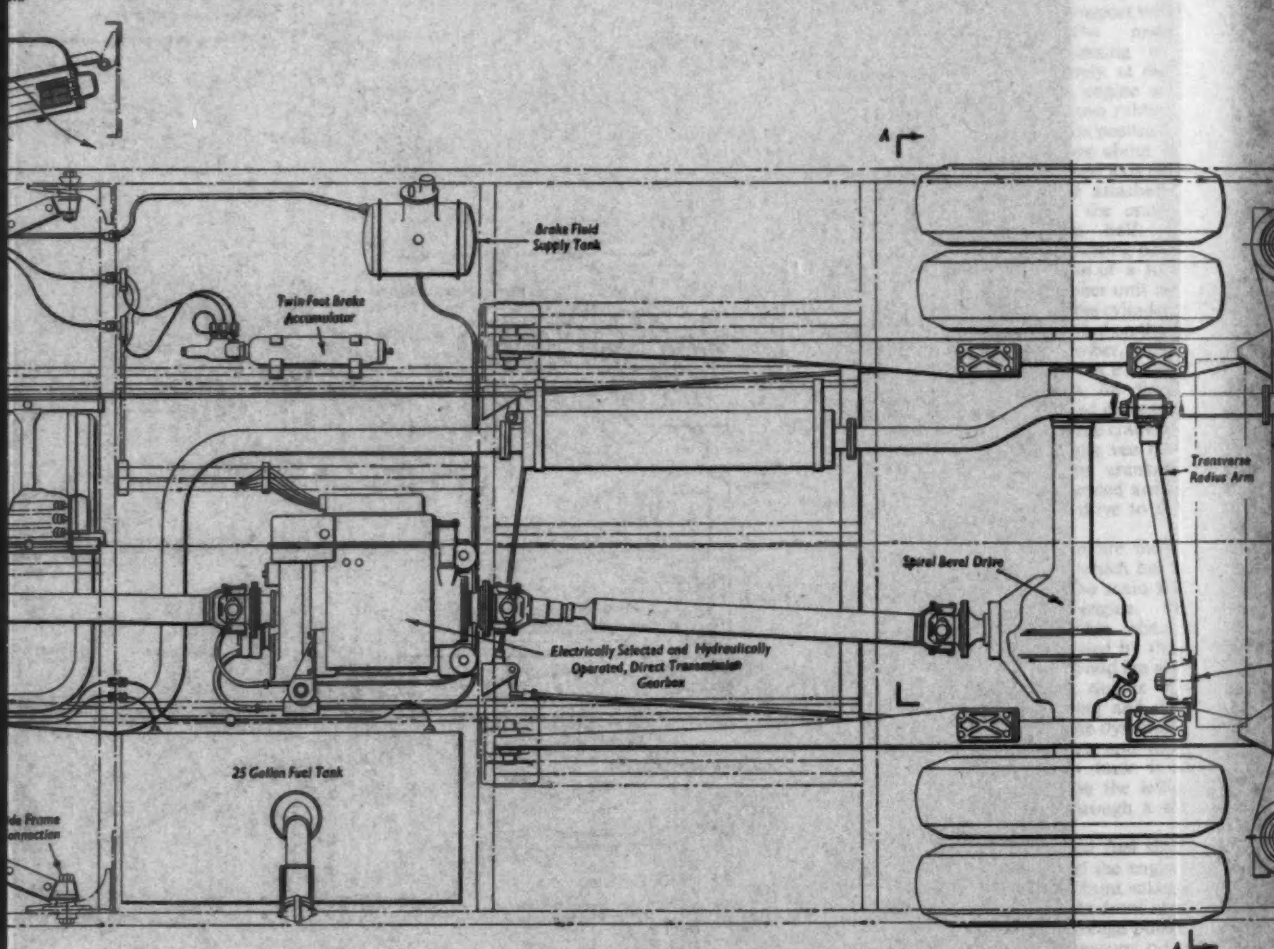
Transmission.—Transmission is through a fluid flywheel and independently mounted epicyclic gearbox, having the brake bands operated

GENERAL ARRANGEMENT OF MECH

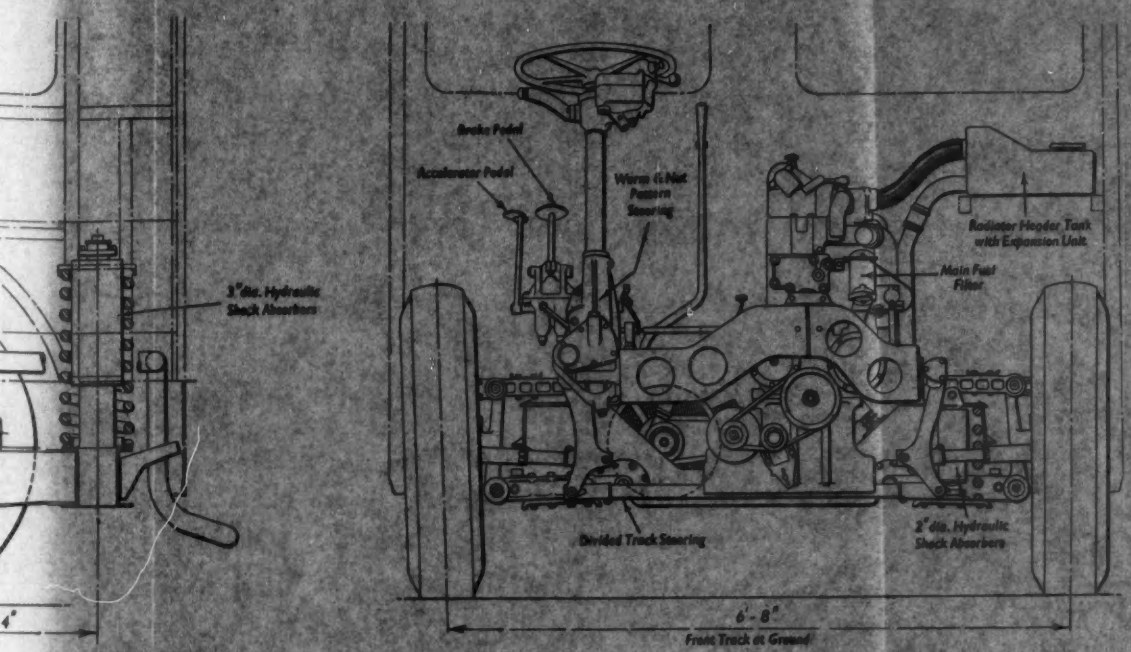


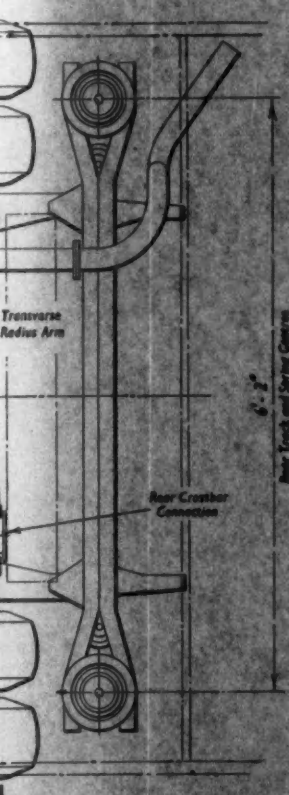
ANGEMENT OF MECHANICAL UNITS FITTED TO 64-SE

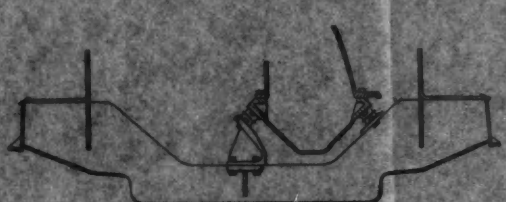



Brake Fluid Supply Tank
Twin-Foot Brake Accumulator
Transverse Radius Arm
Spiral Bevel Drive
Electrically Selected and Hydraulically Operated, Direct Transmission Gearbox
25 Gallon Fuel Tank

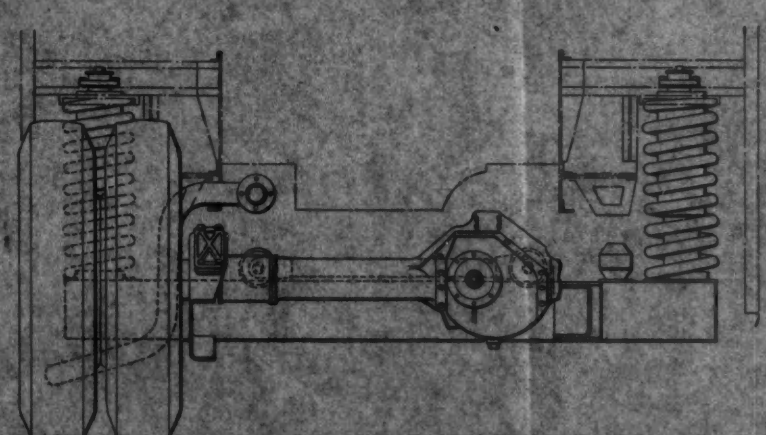
4-SEAT DOUBLE DECKER BUS





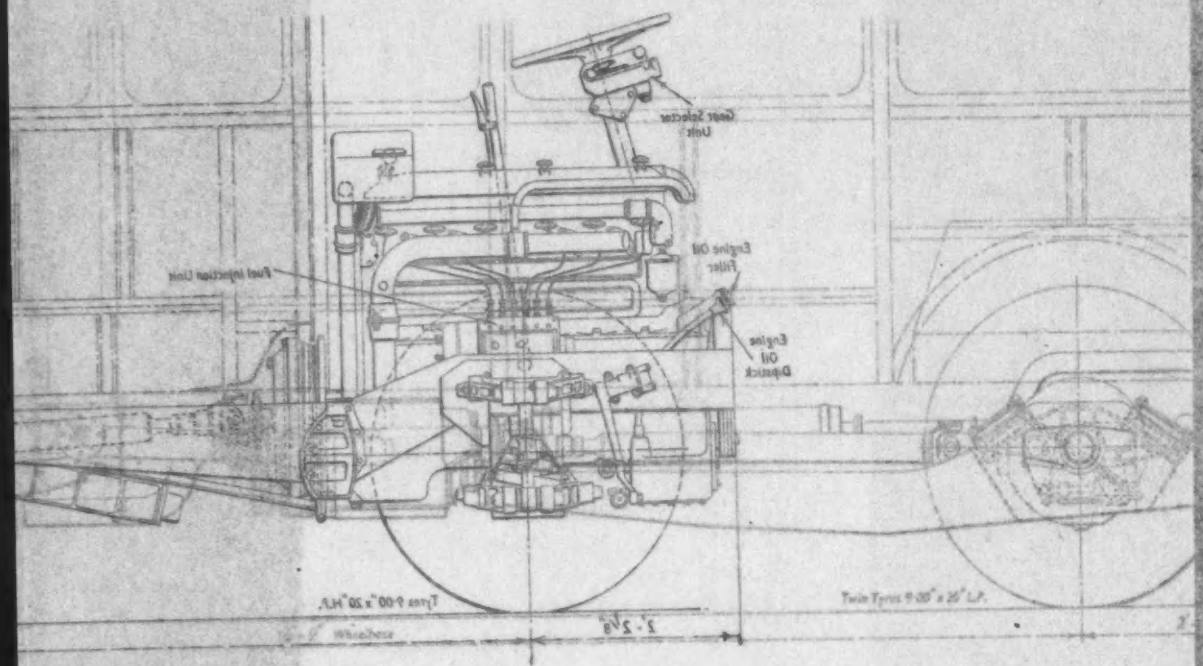


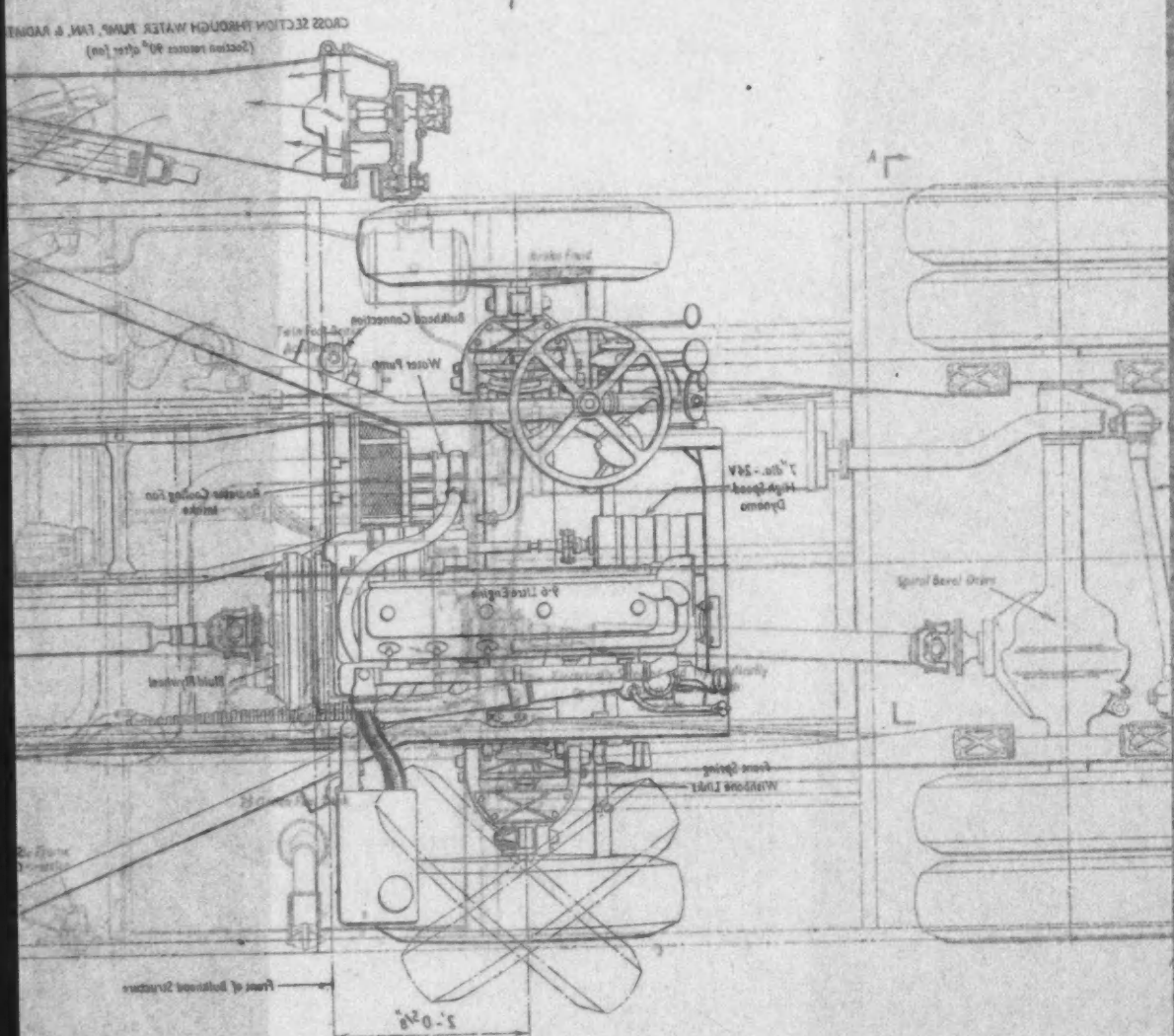
CROSS SECTION THROUGH ENGINE MOUNTINGS.

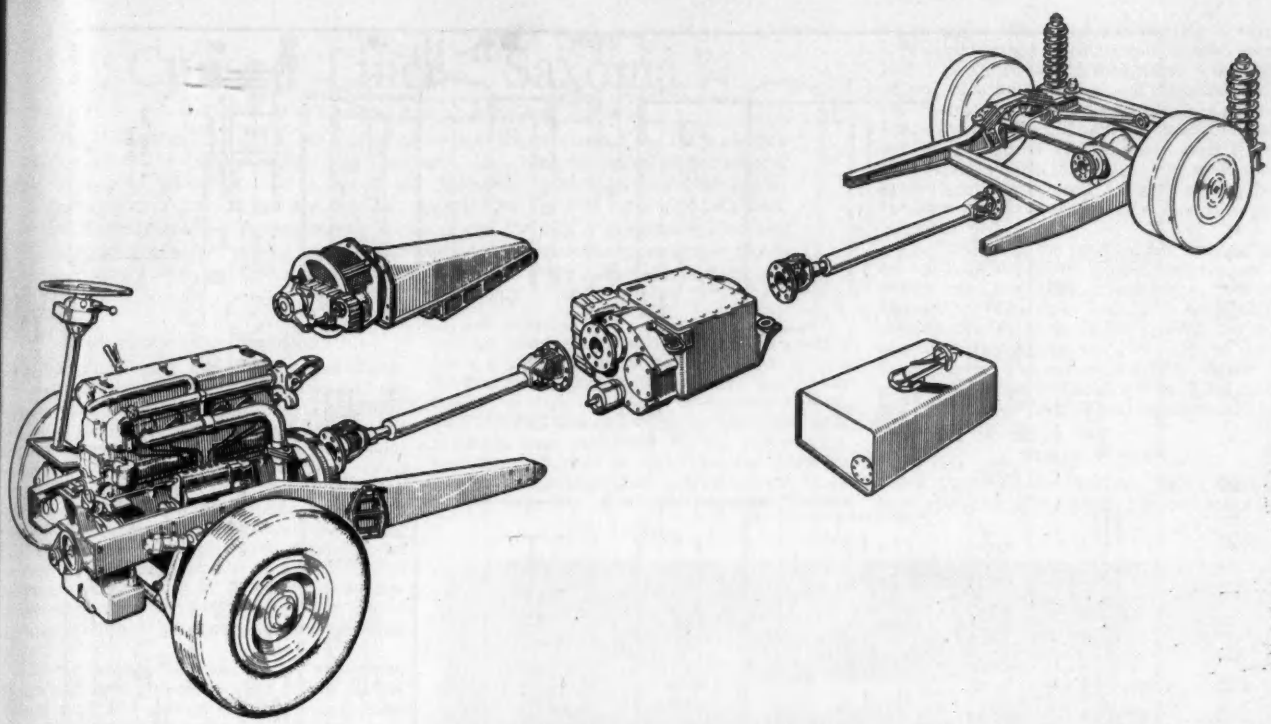


SECTION A.A.

MECHANICAL UNITS FITTED TO 64







The front and rear detachable sub-frames, radiator, fuel tank and transmission units. The front frame carries the independent suspension units, engine and fluid flywheel. The swung rear frame mounts the rear axle and coil spring suspension

by direct hydraulic pressure, eliminating the gear change pedal and providing two-pedal control. Direct gear selection is by electro-hydraulic valves operated from a lever mounted on the steering column. In order to provide similarity with the existing London Transport vehicles the gear change lever, although operating electrical circuits only, actuates in a gate identical with that used on the existing vehicles using pre-selective gearboxes.

The accelerator and brake pedals are carried on the front sub-frame with the steering gear, together with an aluminium floor plate which has a rubber sealing strip to the main body structure within which it can float.

An oil pump mounted inside the gearbox provides hydraulic pressure for the gearbox band operation.

The gear ratios are :

First speed, 4·28 : 1 ; second speed, 2·43 : 1 ; third speed, 1·59 : 1 ; fourth speed, 1 : 1 ; reverse, 5·97 : 1.

The rear axle reduction is by spiral bevel gears and has fully floating axle shafts. The drive unit is offset towards the left hand and the ratio is 5·22 : 1. A forged steel banjo-shaped axle casing has the tube holes bored from the solid.

The crown wheel is mounted on the differential casings which are carried on taper roller bearings in a detachable housing, whilst the pinion is straddle mounted with opposed taper roller bearings and a parallel roller bearing.

The hubs are mounted on two parallel roller bearings separated by distance rings and clamped by large nuts on the axle casing. Lip seals are provided to retain the lubricant.

Rear Suspension.—The main members of the rear suspension are two spectacle radius arms of pressed channel section. They are pivoted at their front end on rubber bushes from brackets adjacent to the third main body bearer. The rear axle casing passes through the "eyes" of the members and is attached to them by two inclined sandwich rubber mountings on each side. The radius arms extend backward and are bolted to an "I" section member of two channels back-to-back which extends across almost the width of the vehicle behind the rear axle, and reacts at its outer ends against the rear coil springs which are housed in the wheelboxes. Telescopic direct-acting hydraulic dampers are enclosed within the springs and progressive rubber bump units are provided. A further light channel member ties the two radius arms together in front of the axle. Lifting of one wheel only is accommodated by the rubber bush anchorage and by allowing the suspension members to weave. Lateral location is by a transverse radius rod extending from a bracket on the right-hand end of the axle casing to the left-hand side of the main body structure.

The rear suspension can be removed as a unit after disconnecting the propeller shaft, hand-brake rod, brake pipes, front pivot pins, transverse rod and spring and hydraulic damper attachments.

Front Suspension.—Independent front suspension is used with unequal length wishbones and coil springs. The wishbone units are each pivoted to the main front cross member (which also carries the engine mounting) and the swivel pin bosses by conical rubber bush units. Conventional swivel pins are fitted in the bosses carried by the suspension wishbones, and the hub assembly using taper roller bearings follows current A.E.C. practice.

The coil springs are fitted between the lower wishbones and the top of the cross member with direct-acting telescopic hydraulic dampers fitted inside the springs. The spring complete, with damper unit, can be removed from underneath by unscrewing eight bolts.

Steering and Braking.—Steering is by an A.E.C. worm and nut unit mounted on the front sub-frame so that the drop-arm moves in a transverse plane. The drop-arm is connected by a steering rod to a similar slave arm on the opposite side of the sub-frame. Short rods connect the steering swivels to the drop-arm and slave arm respectively.

A continuous flow hydraulic foot-brake system operates on all four wheels and the mechanical hand brake on the rear wheels only. All four brake drums are 15½in in diameter with conventional leading and trailing shoes operated by "S" shaped cams, which, in conjunction with worm and worm wheel type slack adjusters, allow the linings to go throughout their lifetime without the necessity of introducing packing pieces.

Hydraulic pressure is supplied by a pump mounted on the front of the gearbox and two bag type accumulators are fitted on the right-hand side of the vehicle. The oil container is on the right-hand side with the filler accessible through the valance. The foot valve is a duplex unit to avoid complete loss of braking in the event of a pipe failure and the operating cylinders work directly on to the brake camshaft levers.

The hand-brake lever fitted on the driver's left-hand side is mechanically connected to the rear brakes by pull rods through bell crank levers without a cross shaft ; 9·00–20 twelve-ply single front and twin ten-ply rear tyres are fitted.

Metal Framing System

WE have received details of a system of metal framing for supporting light electrical or mechanical equipment—pipes, for example—or for racks and storage space. The basic element of the system, which is known as "Unistrut" and is marketed by Sankey-Sheldon, Ltd., 46, Cannon Street, London, E.C.4, is a lipped channel section, 1⅝in by 1⅝in in cross section, made from 12-gauge cold-rolled steel with a corrosion-resistant finish.

This basic channel section is illustrated in the diagram, which also shows the method of assembly. The grooved nut and spring fit into the channel, the grooves fitting into the channel lips. The

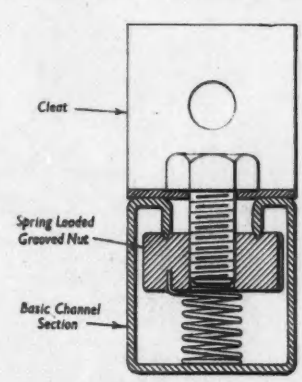
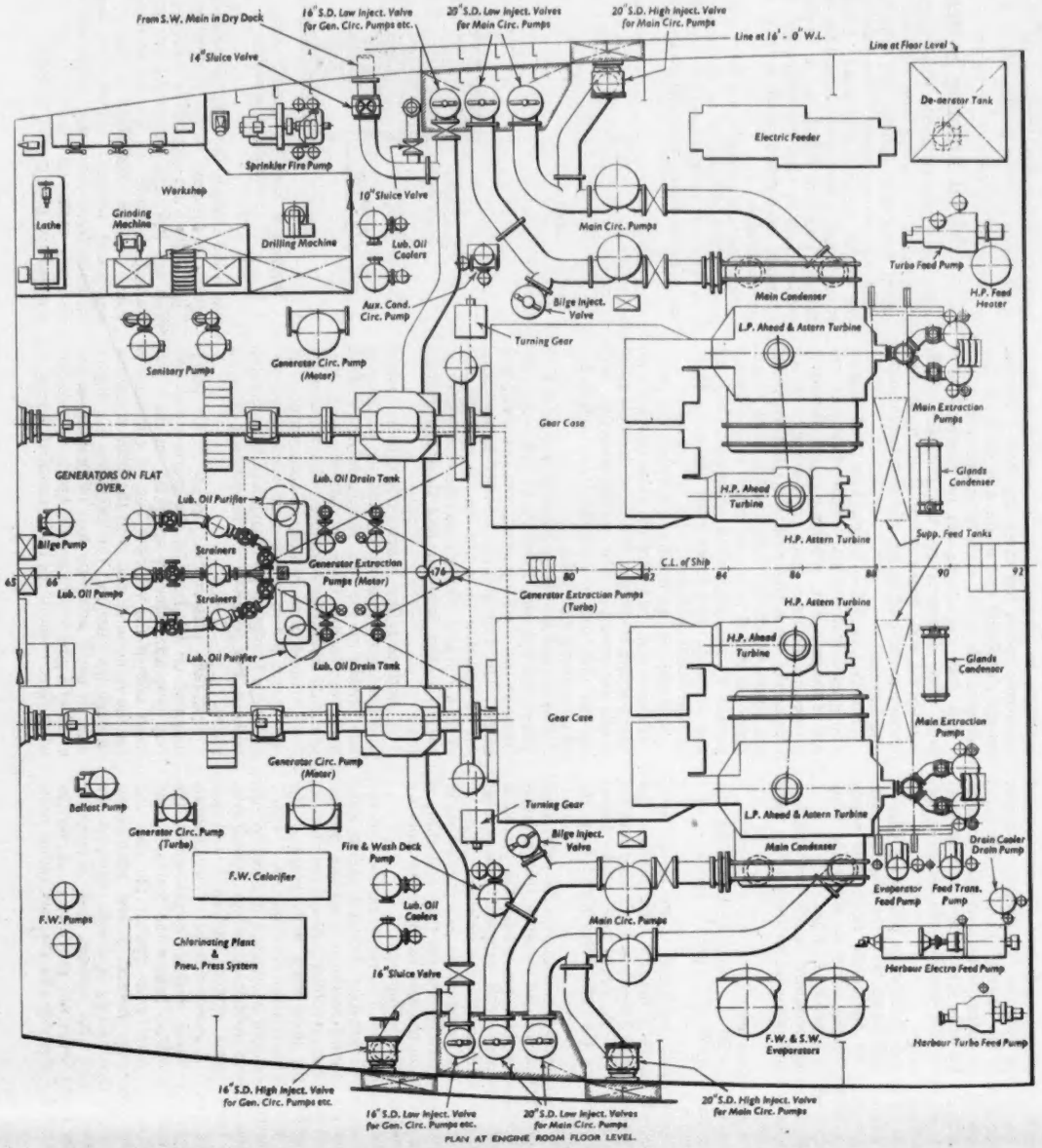


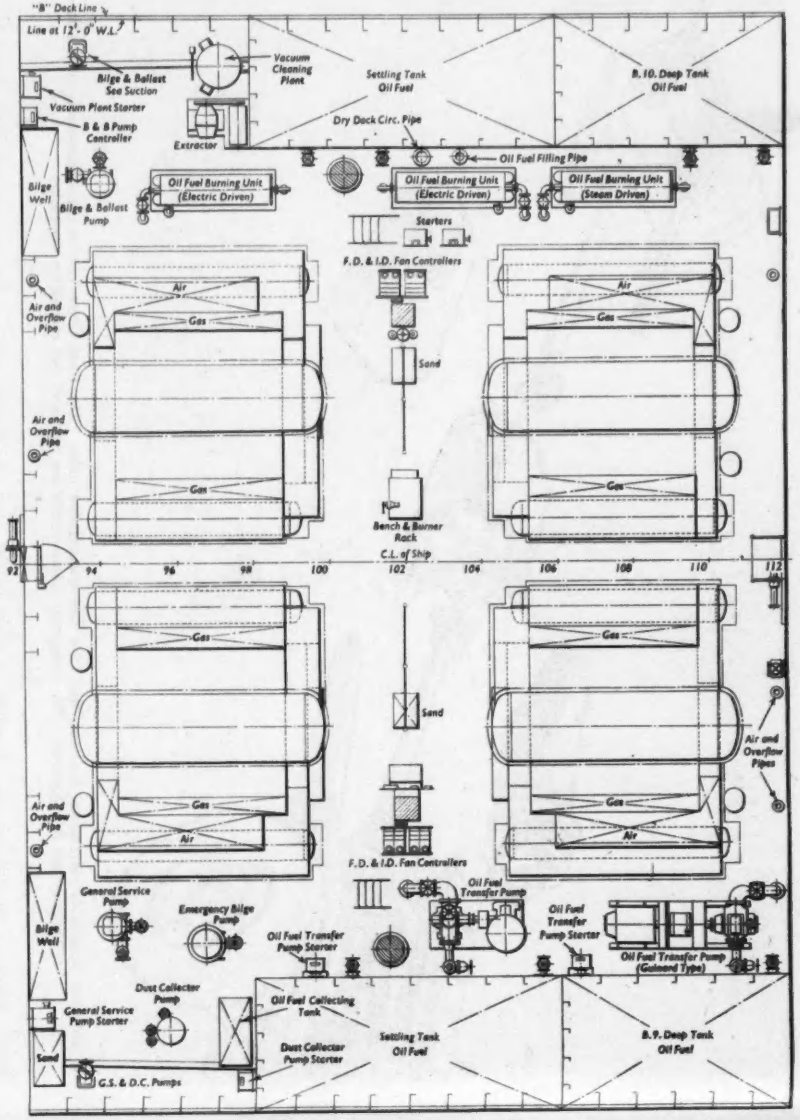
Diagram of basic "Unistrut" section showing method of assembly

nut is slid along to the required position and then a cleat is fastened to the channel with a bolt. The channels are supplied in standard lengths of 10ft and 20ft, and by varying the type of cleat, framed structures of the required shapes and sizes can be assembled. The "Unistrut" equipment includes clamps for carrying the channels from rolled steel joists, and composite channels made up from two or more basic channels to give greater strength.

ENGINE ROOM AND BOILER ROOM OF CUNARD LINER "SAXONIA"



PLAN AT ENGINE ROOM FLOOR LEVEL.



PLAN AT BOILER ROOM FLOOR LEVEL.

Cunard Liner "Saxonia"

No. II—(*Concluded from page 391, Sept. 17th*)

The "Saxonia," which is the first of three new liners intended for the Canadian service of the Cunard Steam Ship Company, Ltd., recently sailed on her maiden voyage to Montreal. A total of 125 first-class passengers and 800 tourist passengers is carried and the ship has capacity for 300,000 cubic feet of cargo. The service speed is approximately 20 knots and the ship is powered by two sets of double-reduction geared turbine machinery taking superheated steam at 530 lb per square inch and 800 deg. Fah. from four three-drum water-tube boilers, and developing 21,500 s.h.p.

Main Propelling Machinery

THE accompanying line drawing and photographs show the general arrangement of the engine-room, boiler-room and starting platform. In the engine-room there are two independent sets of double reduction geared turbines, constructed by the shipbuilders, designed for a steam inlet pressure of 530 lb per square inch gauge and a temperature of 800 deg. Fah. Each set of machinery consists of h.p. and l.p. turbines and together they develop a total normal ahead power of 21,500 s.h.p. at 136 r.p.m. of the propeller and a maximum of 24,500 s.h.p. at propeller revolutions of 144 r.p.m. The astern turbines develop 60 per cent of the normal ahead power.

The h.p. ahead turbines are of all-impulse design and have rotors of solid forged molybdenum steel and casings of molybdenum cast steel. The rotors have been designed so as to reduce the unbalanced steam thrust to a minimum and the h.p. turbine, which has individually fitted blades of stainless iron, incorporates the h.p. astern turbine. This is overhung from the forward bearing of the h.p. turbine and consists of a two-row impulse wheel running in a separate casing of carbon steel with an inlet steam nozzle chest of molybdenum steel. Steam is admitted to the first stage of the h.p. turbine through three groups of nozzles of stainless iron, two of which have individual control in order to achieve greater economy at varying powers. Stainless iron has been used for the diaphragm nozzles, which have centre discs of molybdenum steel in the initial stages, the remaining stages being of mild steel.

Both the l.p. ahead and astern turbines are housed in the same outer casing, the ahead turbine being of double flow all-reaction design and the astern turbine consisting of two rows of impulse blading, all the blading being of stainless iron. The outer casing is of fabricated steel, the inner ahead barrel and the astern cylinder are of cast steel, and the rotors are of solid forged carbon steel.

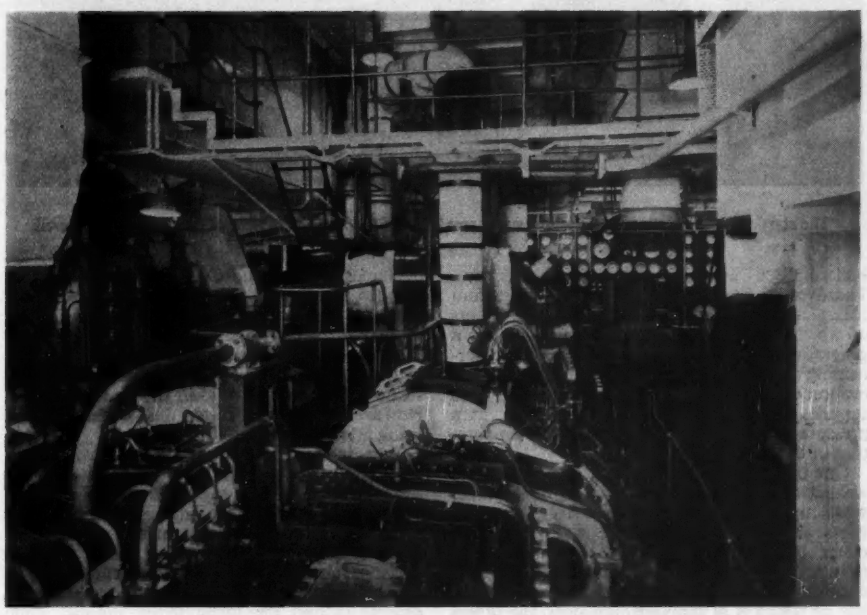
Any unbalanced thrust on the rotors is taken by Michell thrust bearings and any failure of these, causing excessive fore-and-aft movement of the rotor, is indicated by an electric warning indicator. A gland evacuation system is provided and Aspinall's cut-out governors shut off the steam should the turbine revolutions exceed a fixed percentage above the maximum service figure. In addition, steam is automatically shut off should there be any undue drop in the lubricating oil pressure. In the event of a breakdown, provision is made for isolating the damaged turbine and under these conditions it is possible for the h.p. turbine to exhaust to the condenser or steam can be led through a pressure reducing nozzle to the l.p. turbine. For insulation purposes the turbines are lagged with Newalls' "Amosite" asbestos and this material has been used for insulating the boilers, piping, uptakes, and elsewhere in the machinery spaces.

At normal service power the h.p. turbine runs at 4025 r.p.m. and the l.p. turbine at 3700 r.p.m., and both drive through double reduction articulated gearing, each rotor being connected to the gearing by a flexible claw coupling. A separate box, external to the main gearcase, houses the primary gearing and there is a quill shaft between the flexible coupling and the primary pinion and between the primary wheel and the secondary pinion. Both primary and secondary pinions are of forged chrome-molybdenum steel, the primary wheels are of forged carbon steel and the main gear wheels have cast iron centres with shrunk-on forged carbon steel rims. The primary pinions have all-addendum teeth with a pitch of $^{7}/_{16}$in, and the secondary gears are of deep tooth involute design with a pitch of $^{7}/_{16}$in, while the helical angle is 30 deg. To ensure maximum tooth contact and quiet running, the gears, after hobbing, were selectively shaved and meshed, and the gear ratio is such that the propeller shaft, of forged ingot steel, is driven at 136 r.p.m. at service power. A Michell thrust block takes the propeller thrust and the shafting is carried in Michell bearings having a water-cooled bottom half. Two four-bladed manganese bronze propellers, of scimitar design and manufactured by the Manganese Bronze and Brass Company, Ltd., drive the ship and each has blades of aerofoil section, a diameter of 17ft 3in, a mean pitch of 17·23ft, and weighs 14·25 tons. The pitch of each blade face is machined to give a hyperbolic variation from root to tip and a varying angle of incidence.

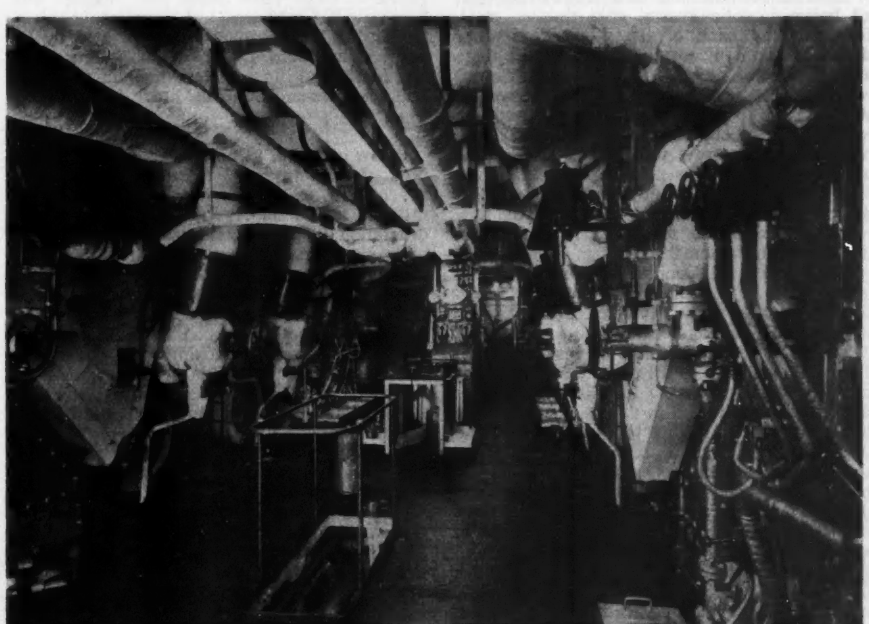
For lubricating the turbines and gearing there are two motor-driven forced lubrication oil pumps and one turbine-driven pump, all manufactured by Drysdale, Ltd., and each unit is capable of delivering 20,500 gallons per hour against a discharge pressure of 50 lb per square inch. Also in the system are four "Serck" oil coolers each capable of dealing with 10,310 gallons per hour and two Alfa Laval purifiers of 2 tons per hour capacity.

Boiler Plant

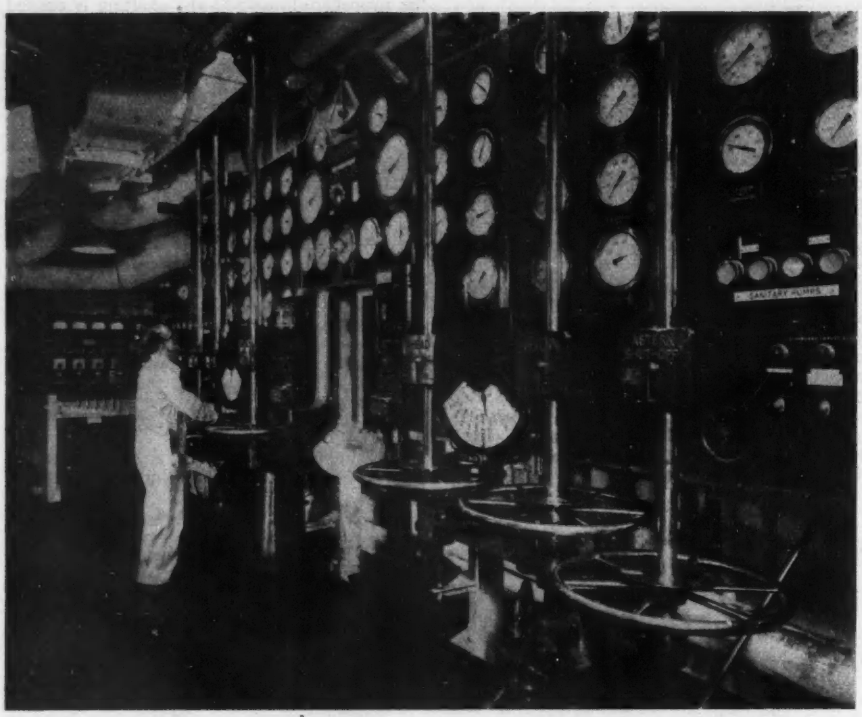
For supplying the necessary steam there are four end-fired, three-drum Yarrow water-tube



Engine-room looking forward towards the starting panel



View looking across the boiler-room to starboard and showing the boiler fronts



The starting platform showing the ample space provided and unobstructed view of the instrument panels

boilers fitted with Melesco superheaters, five Thornycroft burners and Howden-Ljungstrom rotary air preheaters. Each boiler, the fronts of which can be seen in our illustration, has a generating surface of 7684 square feet, a superheating surface of 1800 square feet, a normal evaporation rate of 52,000 lb per hour and supplies steam, at the superheater outlet, at a pressure of 550 lb per square inch and a temperature of 800 deg. Fah.

One of the water drums, both of which are of welded construction, has sixteen rows of tubes consisting of three rows of 2in external diameter tubes and thirteen rows of 1¼in external diameter tubes. Between the third and fourth rows of tubes the superheater is located and consists of sixty elements each of eight tubes, one of which is of molybdenum steel, the others being of mild steel. In the other water drum there are eleven rows of tubes, namely, two rows of 2in o.d. tubes and the remainder of 1¼in o.d., all being of solid drawn, cold finished steel. Fitted at the back of the sixteen-row water drum are two 4½in bore downcomers and there are also two at both back and front of the eleven-row drum. A 5in bore pipe connects the welded steam drum to the superheater inlet and the location of the superheater between the three-row and thirteen-row tube banks ensures the minimum variation of steam temperature. Superheat control is effected by means of coupled dampers, in the uptakes, which regulate the flow of gases across the superheater. A Gordon desuperheating system is fitted.

Open stokehold conditions operate in the boiler-room and the boilers work under Howden's balanced system of forced draught, each unit having a single inlet fan with a capacity of 27,000 cubic feet per minute against a head of 13in water gauge when driven by a 90 h.p. motor over speed range of 320 to 1405 r.p.m. The fans which are situated in the boiler-room draw air through slats below the funnel base and discharge through the Ljungstrom preheaters to the furnaces, the air temperature at the burners being about 400 deg. Fah. Each induced draught fan, with a speed range of 320 to 1405 r.p.m., is driven by a 109 h.p. electric motor and can deliver 39,600 cubic feet per minute of gas against a pressure drop of 10in water gauge. Controls for the fans are at boiler-room level and provision is made for control from outside the boiler-room in case of fire. Clyde hand-operated soot blowers are provided, water level indicators and Mono CO_2 recorders were supplied by James Gordon and Co., Ltd., and Alexander Stephen and Sons, Ltd., manufactured the boiler low level alarm and oil fuel control valves. For supplying oil fuel to the boilers there are three Thornycroft oil fuel pumping and heating units, two having motor-driven pumps and the third a steam-driven pump. Within the funnel are four Howden dry pattern vortex dust collectors, one being fitted to each boiler uptake.

Two independent lines of pipes which are cross connected lead the main superheated steam from the boiler-room to each set of machinery, the pipes forward of the engine-room bulkhead draining forward and those in the engine-room draining aft to the manœuvring valves. A high pressure auxiliary superheated steam range is connected to each boiler and supplies the turbo-generators and the turbo-driven pumps, while desuperheated steam is used for the deaerator, evaporators, oil fuel heating and hotel services. All the large bore pipes are lagged with "Amosite." Cockburns, Ltd., supplied the valves, the electric salinometers were provided by W. Crockatt and Sons, Ltd., Dewrance safety valves are fitted and flow meters manufactured by Bailey Meters and Controls, Ltd.

Closed Feed System

Below each l.p. turbine is underslung a two-flow deaerating and regenerative condenser which forms part of the Weir closed feed system installed in the ship. The system is of double deaeration design, the condensate being deaerated in the main condenser and in a Weir "Optimum" deaerator to ensure full deaeration in all conditions of sea and harbour service. Each condenser has a cooling surface of 11,000 square feet, is made up of 4900 tubes of ⅝in o.d. by 18 l.s.g. packed with Crane's metallic packings, and designed to maintain a vacuum of 29in of mercury with the barometer at 30in and a circulating water inlet temperature of 60 deg. Fah. when the turbines are developing normal service power. For each condenser there are two Drysdale circulating pumps each capable of delivering 8000 gallons per minute against a head of 25ft. In association with each condenser are two extraction pumps, one working and one standby, each driven by a 23·5 h.p. electric motor and capable of withdrawing 78,000 lb per hour normally or a maximum of 170,000 lb per hour against a head of 38 lb per square inch of condensate and discharging this through the main air ejectors, drain cooler glands, evacuation condensers and deaerator to the main feed pump suction. To prevent the re-entry of any corrosive gases into the feed water the condensate in the system is always under pressure.

The capacity of the condensate wells is sufficient to allow for fluctuations in the flow of feed water. The equilibrium of the system is automatically maintained, for should a sudden demand by the feed pumps cause the water level in the condensers to fall then the closed feed controllers allow additional water to be drawn from the feed tank. Conversely, overflow valves discharge excess condensate to the main feed tank. Three steam jet air ejectors, one for each condenser and one as standby, maintain the vacuum and are supplied with steam at 550 lb per square inch and 800 deg. Fah. from the auxiliary superheated steam range. The condensate drains to the main condenser and the ejector condensers are circulated with condensate discharged from the extraction pumps. On leaving the air ejectors, the condensate from both condensers passes through the l.p. heaters, drain cooler and the two glands condensers. Then the feed passes to the low level deaerator and on to the main feed pump and h.p. heater, which is heated by steam bled from the h.p. turbine, when at sea, or by pass-out steam from the turbo-generators when the ship is in harbour or manœuvring. The heater, of four-flow pattern, has an area of 560 square feet and can deal with 213,000 lb per hour, while raising the temperature from 220 deg. to 300 deg. Fah.

Under service conditions the feed water, at 300 deg. Fah., is delivered to the boilers by an eight-stage feed pump, driven by a 450 h.p. motor, having a capacity of 213,000/277,000 lb per hour against a pressure of 775 lb per square inch. There is a standby turbine-driven three-stage feed pump, of the same capacity, which is started up, in the event of failure of the electrically driven unit, by an automatic cut-in device operated by a fall in pressure in the feed discharge line. For harbour duty a nine-stage feed pump, driven by a 135 h.p. motor, able to deliver 50,000/65,000 lb per hour is provided, and a turbine-driven pump of the same capacity is fitted as standby complete with automatic cut-in arrangements. Both the main and harbour feed pumps are supplied by the deaerator extraction pump, which is rated at 213,000/277,000 lb per hour, or when the deaerator is not in use, by the main extraction pumps, of which there are four, each having a capacity of 78,000 lb per hour. "Arca" regulators control the steam to the deaerator and included in the Weir closed feed system are a Caird and Rayner filter, a Drysdale drain cooler drain pump of 22,030 lb per hour capacity, and an auxiliary condenser associated with a Drysdale turbine-driven circulating pump rated at 500 gallons per minute.

Auxiliaries in Machinery Spaces

Fresh water for boiler feed make-up is supplied by two Weir vertical evaporators, each capable of producing 60 tons per day of distilled water from raw water. One unit is fitted with a brine ejector so that it can evaporate sea water, the vapour being distilled and passed to a storage tank. Number two evaporator draws only from this tank. Turbo-generator pass-out steam is supplied to the coils of both evaporators and the evaporator feed is treated by the "Aquastat" electrical process, which treats the feed water with a small electrical potential to prevent the formation of scale.

The majority of the pumps are electrically driven, mainly by motors supplied by Laurence Scott and Electromotors, Ltd. G. and J. Weir, Ltd., supplied the pumps included in the closed feed system and Drysdale and Co., Ltd., provided a general service pump, a bilge and ballast pump, a bilge pump and an emergency bilge pump, each rated at 180 tons per hour, a fire and wash deck pump of 200 tons per hour, and a ballast pump to deliver 250 tons per hour. Stothert and Pitt, Ltd., was responsible for the oil fuel transfer pumps, one, a rotary displacement pump of 100 tons per hour and the other a Guinard pump with a capacity of 117 tons per hour. The two motor-driven oil fuel pressure pumps, each of 10,000 lb per hour, were manufactured by Hamworthy Engineering Company, Ltd., and a third of the same capacity, but steam driven, was supplied by G. and J. Weir, Ltd. There are two

One of the 750kW turbine-driven generators

Broom and Wade compressors and a 100 tons per hour oily water separator.

Special attention has been paid to the ventilation of the engine-room and air is supplied by four torpedo fans, each of 37,000 cubic feet per minute capacity, and sufficient to provide fifty changes of air per hour. To assist the ventilation fans exhaust from points where high temperatures occur and these fans consist of two of 20,000 cubic feet per minute capacity for the main engine-room and two of 5000 cubic feet capacity to serve the generator flat. For the boiler room there are four 17,500 cubic feet per minute exhaust fans provided to maintain ventilation at low powers. All the fans were manufactured by Thermotank, Ltd. At the aft end of the engine-room and to port is the fully equipped engineers' workshop, above which is the laboratory for the testing of feed water and oil fuel.

Electrical Generators

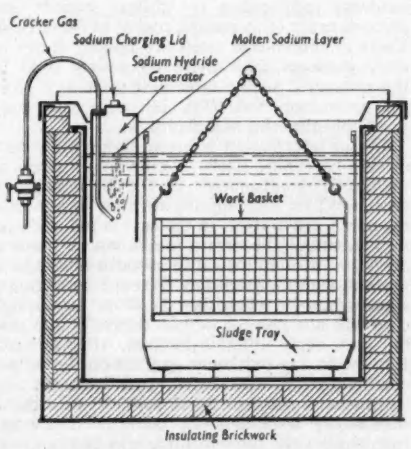
To provide the electrical power required for the heating and lighting of the ship, for hotel and domestic services, for the ventilation systems, and the auxiliary machinery in the engine and boiler rooms, the ship is equipped with four turbine-driven generators, constructed by W. H. Allen Sons and Co., Ltd. Our photograph illustrates one of these units, each of which has a full-load output of 750kW at a pressure of 225V d.c., an overload capacity of 10 per cent continuously, and they are arranged to pass out up to 20,000 lb of steam per hour at 60 lb per square inch gauge. The turbo-generators, which are mounted on a flat at the aft end of the engine-room, each consist of a multi-stage turbine taking steam at 525 lb per square inch and 790 deg. Fah., running at 8000 r.p.m. and driving the generator at 800 r.p.m. through double helical gearing. Each turbine is mounted on its own condenser, which is designed to give a vacuum of 29in of mercury with a sea water temperature of 60 deg. Fah. The generators have single pedestal bearings, are level compound wound and are designed for parallel operation. There is a Weir turbo-generator closed feed system, including four motor-driven and one steam-driven extraction pumps, each of 7200 lb per hour capacity. For each pair of generators there is a 4000 gallons per minute salt water circulating pump, with a third pump, a turbine-driven unit, of 2000 gallons per minute capacity, provided to supply one group of generators. In the boiler room, at the engine-room starting platform, in the galley and at the main switchboard there is fluorescent lighting, and the necessary plant consists of two 25kVA, three-phase, 220V motor alternators.

In addition to the main sets there are two emergency diesel-driven generators, located in a room aft on the port side of the boat deck. Each unit consists of a 75kW Laurence Scott generator driven by a six-cylinder Ruston and Hornsby diesel engine arranged for air or battery starting. The main switchboard, supplied by Whipp and Bourne, Ltd., is arranged on an athwartship platform at the aft end of the engine-room.

Sodium Hydride Descaling Process

Descaling by sodium hydride was recently demonstrated by Durtnall and Hipwell, Ltd., of Staines, Middlesex. The company operates this process under licence from Imperial Chemical Industries, Ltd.

The actual descaling is carried out in a tank containing molten sodium hydroxide at about 370 deg. Cent., together with 2 per cent sodium hydride. After preheating the work to 200 deg. to 300 deg. Cent., in order to dry it out completely and prevent chilling of the bath, it is lowered on chains or in meshed wire baskets into the tank. Sodium hydride is a powerful



Descaling tank showing method of generating sodium hydride in situ

reducing agent, and once the work has reached the temperature of the bath, all rust and scale are reduced within a matter of seconds or at most minutes. In addition, the last traces of any sand are removed by converting it to sodium silicate.

The tank is about 7ft long and has a working space of 6ft by 4ft wide by 4ft deep. The remainder is occupied by a rectangular bell for the generation of sodium hydride *in situ*. As shown in the diagram, charging holes are provided for adding sodium metal, and a mixture of hydrogen and nitrogen from an ammonia cracking plant is bubbled through the melt, forming sodium hydride. Nitrogen and excess hydrogen escape through the space around the charging hole covers, where the hydrogen is burnt. Average consumption is about 5 lb of sodium and 60 to 100 cubic feet of cracked ammonia per hour, and about 1 ton per hour of medium-size castings can be treated. Penetration of the bath is good, e.g. a coil of wire can be treated without removing the binding.

The hydride attacks only the surface oxides, converting them into easily removable metal powder or flakes (or, in the case of chromium, into a lower oxide), but leaves the metal itself completely intact.

The method is stated to be suitable for most metals including stainless steels and light alloys. It can be applied to titanium, and is in fact the only process which is suitable for that metal. Tin and zinc and their alloys are exceptions, since they are attacked by sodium hydroxide.

After treatment the articles are quenched in cold water, when the steam formed removes most of the scale. Where immediate quenching is detrimental, some air cooling is allowed to occur first. The process is normally completed by hosing with a jet, followed by swilling in hot water, but a bright dip and final hot water rinse may be applied if a bright surface is required.

Electric Soldering Iron

An electric soldering iron, now being made by C. I. Casey (London), Ltd., 49, St. James's Street, London, S.W.1, is designed for simple high-speed operation using 18-gauge cored solder. The iron, as can be seen from the illustration below, is of pistol grip design and it operates on a 6V d.c. supply. The current, of 7A, can be taken either from an ordinary accumulator or from a.c. mains via a transformer. The tool has a hollow carbon tip with a glass tube liner, through which the solder wire is fed. The carbon

Electric soldering iron for use with cored solder and having thumb-operated feed from a coil in the body of the tool

tip forms one electrode and the solder wire the other, so that when the work is touched by both the circuit is completed and the arc melts the solder. When the projecting piece of solder has melted the circuit is broken automatically.

The cored solder is supplied from a feed reel mounted in the body of the tool, and after each soldering operation depression of a thumb pad feeds another length into the tip ready for the next piece of work. When it is required to remove solder from a workpiece the feed solder is drawn back into the tool and, by sliding a brass collar down on the feed tube, a pin is pushed out of the feed orifice. On the pin and the carbon tip then being placed in contact with the solder to be removed, it is quickly melted.

Coal Board's University Scholarships.—The National Coal Board states that university scholarships in mining engineering and allied subjects have been offered this year to thirty young men already working in the industry and forty-five boys from outside it. Last year a total of sixty-nine scholarships were awarded. The scholarships cover the whole cost of education and carry a maintenance allowance which may amount to £300 a year. During the last four years, eighty-one N.C.B. scholarship holders have won honours degrees and eighty-four have taken pass degrees. The Board says that the number of awards given this year to people from outside the industry is the highest since the scheme started seven years ago. The Coal Board would like to be able to award 100 scholarships each year, but the highest number so far achieved is the eighty-eight awarded in 1949, when there was still a comparatively large pool of qualified men in the industry. It is not, however, the Coal Board's intention that all the industry's future managers will hold university degrees. There will always be ample provision for men who are already in the industry and are able to qualify for managerial posts by part-time study. Every facility is given for young men to do this, including paid release during working hours for study at technical colleges.

Metallurgical Topics

Metals Handbook Supplement

THE *Metals Handbook*, published by the American Society for Metals, is unrivalled as a comprehensive and informative cyclopedia of metallurgy. The latest edition appeared in 1948. The task of keeping this up to date is assigned to the *Metals Handbook* Committee, whose members have studied the 1948 edition and selected the sections in which the greatest advancement has been made, and have determined the desirability of presenting new and additional information in a supplement. This supplement, comprising twenty-four separate articles, the work of twenty-two sub-committees, is published as a special number of *Metal Progress* (Vol. 66, No. 1A, dated July 15, 1954). The same journal contains biographical notes of members of the Metals Handbook Committee and of chairmen of the sub-committees. It is of interest to note the subjects selected for treatment in this first supplement. They fall under the headings :—

Metals and Applications.—Selection of constructional steels, selection of tool steels, stainless steels, heat-resisting alloys, nodular cast iron, applications of aluminium and aluminium alloys, selection of copper and copper alloys, magnesium and magnesium alloys, titanium and titanium alloys.

Design and Application.—Engine metals and engine wear, effect of stress concentration on design strength, shot peening and other surface working processes, design of ferrous castings, and design of brazed joints.

Processing and Testing.—Carbonitriding, the agitation of quenching media, the cost of heat-treating, selection of metal cleaning methods, press forming of sheet steel, machining of steel and cast iron, machining, joining and finishing of powder metal parts, steel melting, selection of methods for non-destructive inspection, and metallography.

Most of these are supplementary to articles which appeared in the 1948 edition, but some new subjects, which had no mention in the previous edition of the handbook, are included ; for example, nodular cast iron, titanium and titanium alloys, and the press forming of sheet steel. From the wealth of new information contained in this supplement it is possible to mention only a few items which may be of general interest.

Iron and Steel : Steel Melting

In the article on steel melting, advances that have been made during the last decade receive notice. In Bessemer practice the principal advances noted have been in the direction of larger converters of improved design, wider use of spectroscopic and photocell methods of detecting changes in the Bessemer flame, and the control of nitrogen and phosphorus contents by oxygen treatment and surface blowing. Modifications in the design and working of basic open-hearth and basic electric furnaces are described. Two new techniques are also discussed, vacuum melting and continuous casting of steel. Continuous casting of non-ferrous metals is conventional practice and the continuous casting of large quantities of steel into relatively small billets has attracted steel makers for many years because it would eliminate the expensive cogging equipment required for breaking down large ingots, an advantage which may appeal mainly to the smaller producer. A continuous casting machine is described from which round, square, rectangular or oval sections can be cast at rates varying from 5 tons to 20 tons per hour, all in killed steels. The direct economic advantage is increase in yield, which, on account of the elimination of top discard and other crop losses, may reach 95 per cent of the molten metal. Technical problems are much greater than with non-ferrous metals on account of the higher temperatures involved and the lower heat conductivity of steel. For these reasons, the continuous casting of steel is still in the development stage. A demand for vacuum melting capacity has arisen in the United States owing to the improvement in physical and mechanical properties shown by some vacuum melted steels. Production is still limited to ¼-ton and ½-ton operations, but an improved furnace which may deal with 1 ton is described. The furnace incorporates vacuum locks to permit charging of raw materials and discharging of ingots without exposing the melting crucible to the atmosphere.

Constructional Steels

The steels considered are those carbon and alloy steels used in the general construction of machinery, both stationary and mobile, and the problem of selection is dealt with by determining which of the physical and mechanical properties are important and then choosing the material that provides these properties at the lowest final cost. In addition to having the required favourable properties, the steel must be free from unfavourable properties that would preclude its use, among which is susceptibility to brittle failure. The properties which, for various applications, are of primary importance are considered, and the possibility of securing them in hot-rolled, cold-drawn or hardened and tempered low alloy or carbon steels is discussed in detail. Response to heat treatment is frequently a major consideration in the selection of a steel and charts are given, showing the composition limits and hardenability bands for the current list of S.A.E.-A.I.S.I. standard alloy steels (about 100 in number) that can be purchased on a hardenability basis. For quick reference, also, lists of steels that have the minimum hardenability necessary to meet the hardness requirement in various sections are given in order of increasing cost as at May, 1954. These minimum-cost steels are notably lower in alloy elements than those commonly used in this country. Such a table may serve as a basis for preliminary valuation, but experience may justifiably alter this first choice.

Useful information is given about the choice of case hardening steels. Compression stress in the case is an advantage. As the hardness of the core increases and approaches that of the case the compressive stress in the case is reduced and may eventually become a tensile stress. Such a condition is often the cause of tooth breakage in gears though the steel may be tough by ordinary standards. On the other hand, a soft tough core will not prevent fatigue failure of the case but only delay ultimate fracture. For satisfactory use in any particular application the proper combination of case depth, core hardness and treatment must be developed to provide a satisfactory residual stress pattern. There has been increased use of carbonitriding and its advantages and disadvantages are described in a separate article. Its major advantage is increased hardenability of the case which makes it possible to oil-quench carbonitrided plain carbon steel parts, thus achieving minimum distortion and better control of dimensions. On the other hand, the time required makes the production of a case depth greater than about 0·025in uneconomical.

Tool Steels

Detailed consideration is given to the selection of steels for each of seventeen important kinds of tools. A new classification of tool steels, different from that given in the 1948 handbook, is employed. The opinion is expressed that for cutting tools there is little difference between the molybdenum and tungsten grades, though for special purposes some steels (e.g. tungsten-cobalt-chromium-vanadium) have no counterpart in the other group. Since there are adequate supplies of molybdenum in the United States, whereas most of the tungsten is imported, the use of molybdenum has increased rapidly. In the year 1949 about 40 per cent, and in the years 1951-54 between 80 and 90 per cent of all the high speed tool steel produced in the United States was of the molybdenum type.

For the relatively new process of the hot extrusion of steel, the dies recommended are those employed for the more severe types of hot forging, i.e. tungsten-chromium steels of hardness Rockwell C32-40 (approximately 300-400 Brinell). For intricate sections the lower hardness within this range is recommended. For solid rounds a chromium-molybdenum-vanadium steel of Rockwell hardness C50-55 (Brinell 490-540) is considered suitable.

Stainless Steels and Heat-Resisting Alloys

Information given in the 1948 handbook is partly superseded by a new account of the physical properties and working characteristics of about thirty different stainless and heat-resisting steels, though by far the highest production in 1953 was of the straight, low-carbon chromium type, when the output of this steel exceeded that of all the austenitic stainless steels by 96 per cent, largely owing to the demands of the automobile industry. Aircraft and railway passenger coaches made use of quarter-hard or half-hard austenitic sheet or strip of the 18 : 8 or 18 : 10 variety. All the other compositions mentioned had restricted, though sometimes important, applications. Freedom from intergranular attack in strongly corrosive applications is provided for by the addition of titanium (minimum, five times carbon content) or niobium (minimum, ten times carbon content). These two steels are regarded as interchangeable for most purposes. The production of stainless steel castings has increased markedly since 1949, and changes have been made in standard compositions, mainly to improve castability.

In the article on heat-resisting alloys, various forms of high temperature tests, their application to design and their significance in the selection of heat-resisting alloys, are discussed. Many of the alloys were unheard of in 1948, and additional data are provided to supplement the earlier account, but there is no list of references as in many of the articles. Though justice could hardly be done to this rapidly expanding subject in the short space available, reference might have been made to the several symposia which have been held, and books published, on high-temperature alloys since 1948.

Non-Ferrous Metals and Alloys

The main developments in the aluminium industry since 1948 are summarised and applications of aluminium in the principal consuming industries are described in detail. In reduction technique, the trend has been towards increased use of the Söderberg continuous electrode, which apart from economy of material, makes it possible to enclose the cell for gas removal. Mechanically, notable progress has been made in large extruded and forged shapes. The properties of six alloys which have recently gained industrial importance, with their typical uses, are given in detail, and those of fourteen others more briefly.

A valuable article on the selection of copper and copper alloys is divided according to the principal factors which govern particular uses, and deals with well-established alloys, the properties of which are already tabulated in the 1948 handbook. In the article on magnesium and magnesium alloys, however, new information is given on production, processing, applications and properties. The annual consumption of magnesium in the United States is between three and four times what it was in 1948. Utilisation of sheet has increased and so also has the use of magnesium alloy die castings. Sand castings and permanent mould castings now account for 65 per cent of the output. Since 1948 a notable improvement in grain refinement has been made by carbon inoculation, which consists of introducing a volatile carbon compound into the melt at about 740 deg. Cent. and cleaning the melt with flux in the usual way afterwards. Improved foundry techniques have also made possible the production of large, intricate, thin-walled castings for use in aircraft and air-

borne products. The increased use of magnesium since 1948 is partly due to the development of new alloys, and the properties of five of these are given in detail, viz., Mg-Al-Zn-Mn and Mg-Zn-Zr for sand castings, Mg-Zn-Zr for extrusion and use at normal temperatures, and two grades of sand cast magnesium-rare earth-zirconium alloys for applications requiring good creep strength at 150 deg. to 250 deg. Cent. The use of magnesium for the cathodic protection of steel against corrosion is also described.

As already mentioned, titanium is a subject new to the handbook. Commercial production of titanium rose from 3 tons in 1948 to 2250 tons in 1953, and the target in America for 1956 is 20,000 tons. All commercial titanium is produced by the Kroll process—magnesium reduction of titanium tetrachloride. The article gives a concise account of methods of production, properties, possible applications and principles of design of components in titanium and titanium alloys.

Design and Application

The successful application of metals and alloys is dependent on good design ; hence the value of the five articles under this heading. In the first, the general discussion on wear in the 1948 handbook is supplemented by detailed consideration of fourteen classes of component of the internal combustion engine that are subject to wear. Stress concentration caused by the shape of a member is generally recognised as a frequent cause of fatigue failure, and the second article describes a method for analysing design and metal jointly, by the aid of stress concentration factors combined with notch sensitivity tests and the von Mises criterion of failure for ductile materials, to produce a component to withstand service stresses. Apart from the over-riding importance of improved design, there are other methods of reducing stress concentration. Shot peening and other surface working processes have an article to themselves, but case hardening, nitriding and other heat treatments can also be considered in the general category of surface strengthening methods. Failure to meet fundamental design requirements is responsible for many defective castings, and in another article illustrations are given of how to correct bad features in the design of ferrous castings, while an extensive article on the design of brazed joints also gives illustrations of good and bad practice and describes the mechanical properties of brazed joints produced by different processes.

Processing and Testing

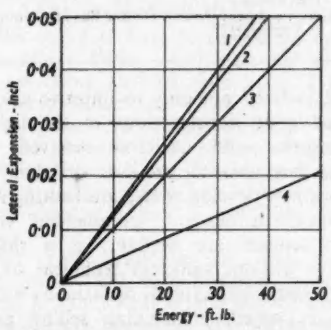
Several of the articles (not already mentioned) under this heading are mechanical rather than metallurgical, but mention may be made of the last two. The article on non-destructive inspection does not describe any new method, but compares methods that were already well known in 1948 and deals with the selection of one or more methods for specific purposes. In the article on metallography there is, however, evidence of the considerable advances made in technique during the last six years, particularly in vacuum etching, phase contrast metallography and electron metallography.

The publication of these carefully chosen articles which form the first supplement of the 1948 edition of the *Metals Handbook* will greatly increase the serviceability of the original volume.

Deformation in Notched-Bar Tests

In considering the effect of temperature on the results of notched-bar impact tests on materials which do not show a sharp transition from tough to brittle fracture, the value adopted for the transition temperature is dependent on the criterion by which this temperature is defined. In 1948 A. B. Kinsel[1] suggested the use of lateral contraction of the test piece as a criterion of transition temperature, basing his suggestion on the perceptible reduction in cross section of a plate when fracture ceases to be entirely brittle. He defined the transition temperature of a 3in wide notched bar as that temperature at which the specimen showed a 1 per cent lateral contraction parallel to the notch. The value of 1 per cent contraction was selected as it corresponded approximately to the deformation encountered in service failures at a section near the place at which the crack ceased to spread. Since then C. E. Hartbower and W. S. Pellini[2] have investigated the lateral contraction of steels in various conditions, tested over a range of temperature which included the transition range. From measurements of over 200 Charpy test pieces they found a simple straight-line relationship between maximum lateral contraction and the energy absorbed, and this linear relationship was independent of testing temperature, orientation of the notch, grain size, and other variables in microstructure.

The measurement of maximum lateral contraction just below the notch was found to be a very difficult and tedious process, and lateral expansion on the compression side of the specimen could more easily be accurately measured. As a linear relationship was also found to exist between the maximum lateral contraction near the notch and the maximum lateral expansion at the compression surface of fractured V-notch Charpy specimens, the latter criterion was adopted by C. E. Hartbower[3] in an investigation of lateral deformation in relation to energy absorbed. The experiments were made on three 0·2 per cent carbon steels (aluminium killed, silicon killed and rimmed) with keyhole notch, V-notch and double-width V-notch Charpy impact and V-notch Charpy slow-bend specimens. Further impact tests were made with Charpy keyhole and V-notch specimens on twelve normalised carbon-manganese steels, containing carbon 0·04 to 0·45 per cent, and manganese 0·43 to 1·05 per cent, at temperatures between −100 deg. and +100 deg. Cent. The results showed that a linear relationship exists between the lateral deformation and the energy to fracture Charpy test pieces of pearlitic steels up to a point beyond which the deformation fell away progressively from the straight-line relationship and tended towards a constant value. The linear relationship extended over a range of 0 to 50ft-lb in the case of the V-notch Charpy impact specimen, and over a range of 0 to 40ft-lb in the case of the keyhole specimen. There is, however, a difference in the amount of energy corresponding to a given deformation at fracture for the different kinds of specimen in the same general type of steel, as shown in Fig. 1. Thus, a lateral contraction of 5 per cent, or approximately 0·02in, corresponds to an energy absorption of 20ft-lb by the V-notch impact, 16ft-lb by the keyhole impact, and 15ft-lb in the V-notch slow-bend test. To produce the same actual deformation (0·02in, or about 2½ per cent) in the double-width V-notch impact specimen would require nearly 50ft-lb. Thus a comparison of curves of maximum lateral expansion against work done in producing fracture provides a measure of the relative resistance to deformation of the various types of test piece. The existence of the linear relationship between lateral deformation and energy absorbed, however, obviates the necessity of measuring lateral expansion or contraction in the Charpy impact test, since the energy, read directly from the calibrated machine, provides the full equivalent of information.



1. V-notch, slow bend. 2. Keyhole notch, impact.
3. V-notch, impact. 4. V-notch, impact, double width

Fig. 1—Relation between energy and deformation in fracturing Charpy specimens (Hartbower)

It is of interest to recall that, many years ago, undue emphasis was placed on measurement of angle of bend as giving additional information to that provided by the impact figure. This proved not to be so, even when angles of bend were measured in tests over a wide range of temperature. In the work of R. H. Greaves and J. A. Jones[4] curves given by angle of bend took the same form as those given by energy absorbed up to about 60ft-lb with the V-notch test piece. They gave a sharp indication of a minimum at the same temperature as that given by the energy absorbed ; but gave no information about the course of the curve above 60ft-lb, as at this stage test pieces all remained unbroken and thus all showed the same angle of bend (the maximum imposed by the Charpy machine). P. Goerens and G. Hartel[5] studied angles of bend very carefully and came to the conclusion that the angle of bend was at a minimum at the same temperature as the energy absorbed. The practice of measuring the angle of bend was subsequently given up, as the information derived from the measurements did not appear to add to that given by the impact figure. Similarly, it seems from the work of Hartbower that measurements of maximum lateral expansion or contraction of the test piece afford no new criterion for judging fluctuations in impact value or for identifying the transition temperature.

References

[1] *The Welding Journal*, 1948, Vol. 27, page 217-s.
[2] *The Welding Journal*, 1950, Vol. 29, page 348-s.
[3] American Society for Testing Materials, Annual Meeting, June, 1954 (Preprint No. 77).
[4] *Journal of the Iron and Steel Inst.*, 1925 (2), Vol. 112, page 137.
[5] *Zeitschrift für Anorganische Chemie*, 1913, Vol. 81, page 130.

Attack of Austenitic Steel by Nitrogen

In nitriding practice, the source of nitrogen is ammonia. Moreover, austenitic steels require a preliminary treatment of the surface to make them susceptible to nitriding by ammonia. Some other source of active nitrogen may be used, but direct nitriding by the nitrogen molecule does not take place, and at nitriding temperatures the molecule is not broken down to make the nitrogen reactive.

It is therefore of interest to note the experience recorded by F. Braumann and H. Krächter* with tubes of austenitic chromium-nickel-molybdenum steel containing chromium 17·4, nickel 9·6, molybdenum 2·6 and titanium 0·6 per cent, after an internal pressure test of 10,000 hours' duration under high-pressure commercial nitrogen at 700 deg. Cent. On the inner wall of the tube they found fine longitudinal cracks and an altered layer. Metallographic study showed this to be a brittle nitrided layer having a depth of 0·2mm to 0·5mm. Transverse sections showed a transition from a dark to a light-etching material, but this did not mark the limit of nitrogen penetration. Nitride particles were visible in the light area as well as in the dark. Two successive layers, each about 0·2mm thick, were therefore separated and used for chemical and X-ray analysis. The chemical composition of the two layers was almost identical, but differed from that of an unused tube in that nitrogen had increased from 0·017 to 2·2 per cent, carbon from 0·09 to 0·2 per cent, and titanium from 0·6 to 1·2 per cent. There was a slight reduction in the chromium and molybdenum content. The increase in carbon was probably derived from a hydrocarbon impurity in the commercial nitrogen, but no explanation was given for the increase in titanium. Comparison of the Debye-Scherrer photographs of the material from the two layers showed that both contained the same nitride constituents, viz. (Fe,Cr)N with varying ratio of Cr : Fe, and Fe_2N. Indications of the presence of austenite were weak in the outer layer, but became stronger towards the interior. It was thought that the distribution of austenite might account for the transition from dark to light etching regions within the nitrided layer.

A crack in the 0·5mm layer (i.e. in more than 10 per cent of the thickness of the tube) might be dangerous and lead to premature failure. The authors therefore suggest that for this high-pressure service, it is preferable to use another gas which, in the given conditions, does not react with the material of the tube, for example, argon, in place of nitrogen.

* *Archiv für das Eisenhüttenwesen*, July–August, 1954, page 373.

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COMMERCIAL MOTOR SHOW, 1954

With the official opening to-day of the seventeenth Commercial Motor Show, the great Earl's Court exhibition hall in London is once again transformed into a show room, displaying a fine range of goods-and passenger-carrying vehicles, together with an almost infinite variety of allied motor products. Although commercial vehicles—in particular those for public passenger transport—play an important part in our daily life, the Commercial Motor Show is not likely to attract the general public to the same extent as the Motor Show which will take place a month later. For that reason, it provides an excellent opportunity for thousands of technically minded people to study the numerous exhibits in detail and undisturbed by the crowds which throng the stands at the Motor Show. Many of these visitors will be particularly interested in examining the vehicles which, built to special export specifications differing from those legally permitted in this country, will not be seen on our roads at all.

There is one aspect of the Show which always tends to engage the attention of the engineer. It is the versatility of the commercial vehicle industry and its readiness to accept new ideas in contrast to the more conservative attitude of the motor industry. The latter has to work on the assumption that, once a new model has been developed to be produced in large quantities, it has to be made for long periods without requiring any major modifications. The manufacturers of commercial vehicles are in a different position. They have to cater for such a great variety of different applications at home and abroad, that the number of chassis built of each individual model, especially in the heavier vehicle class, is comparatively small. Not being committed to the methods of large quantity production to the same extent as motor-car manufacturers, they are more inclined not only to improve acknowledged good constructions in the light of suggestions and criticism received from users, but also to produce on their own accord new developments, constituting major advances in design. Commercial vehicle manufacturers are hesitant, as a rule, to dictate without sufficient technical or economic justification trends or fashions with the primary object of creating selling points. They have to deal with expert customers, frequently with the operators of large fleets of vehicles who know what they want and often have the economic power to ensure that their requirements are being met by the industry. There may be occasional differences of opinion between the parties concerned about the best way of reconciling the "go-ahead" policy of the manufacturers with the cautious and sometimes complacent attitude of the users, but, generally speaking, the co-operation between users and suppliers has been very close. Several examples, displayed at this year's Show, clearly demonstrate the beneficial effect of a co-ordinated design effort. In these circumstances, it is not surprising that the economic position of the commercial vehicle industry is very strong indeed. Thanks to the high standard of its products and its general flexibility to adapt itself to changing circumstances, the industry has more than maintained its rank as a major exporter against strong American and Continental competition. During the first six months of this year more than 126,000 vehicles have been produced, an increase of about 10 per cent compared with the same period in 1953, and the total number exported overseas amounted to 56,000 units. The prospect for the future also looks quite favourable, especially as far as sales on the home market are concerned. The reasons for the increased demand are the general industrial prosperity, the return of road transport to free enterprise, the growing fashion for holiday coach excursions, and, last, but not least, a factor which has a greater influence on the sales of light commercial vehicles than is generally realised, the removal of restrictions on hire purchase.

The industry, therefore, would have fully sufficient reason to be satisfied, if it was not for the fact that economic production is still handicapped by out-of-date regulations which compel our manufacturers to provide a different range of vehicles to meet overseas conditions. Regulations increasing the legal width of goods vehicles of 4 tons unladen weight to 8ft have been proposed by the Minister of Transport and will probably become law in the beginning of next year, but there is no indication so far that the authorities are considering a relaxation of home regulations relating to the speed limits of the different kinds of commercial vehicles. The 20 m.p.h. speed limit on goods vehicles of more than 3 tons unladen weight, for instance, is a serious handicap to the efficiency of road transport, and, indeed, there is no other major country in the world to impose a limit as low as this on heavy commercial vehicles. The vast majority of drivers regularly exceed the 20 m.p.h. limit anyhow. Would it not be sensible if the authorities were to raise this limit to 30 m.p.h., thereby legalising a state of affairs, which has been made possible and sufficiently safe by the efficient brake system of modern vehicles? It is rather difficult to be optimistic in this respect, but it must be emphasised that vehicles built under these restrictions cannot be useful in many overseas markets. Failure to align Britain's regulations with international standards imposes onerous trade restrictions and must necessarily affect the productivity in a manufacturing industry that has made, and is continuing to make, a substantial contribution to this country's exports.

FUEL FOR INDUSTRY

Among the many problems which the industries of this country have had to face in the years since the war, none has caused more anxiety than fuel and power supply. It is a problem which has been, and still is, the subject of many discussions by engineers and scientists, and by representatives of management, trade associations and trade unions. The most recent of such discussions took place at Sheffield last week at a conference of industrialists convened by the Association of British Chambers of Commerce. The conference agenda included many aspects of fuel and power supplies. Consideration was given to the diminishing availability of coal and the increasing industrial demand for it, and there was discussion about fuel efficiency, the price of coal, the use of alternative industrial fuels, and about the probable contribution of atomic energy to Britain's fuel and power problems. The ground was once more thoroughly surveyed both from the policy and the technical aspects, though it is not altogether easy to assess the full extent of the contribution made by the conference to the solution of existing industrial fuel and power problems.

The root cause of those problems is still to be found in the continuing shortage of coal. It is not surprising that the conference of industrialists expressed "serious anxiety" over the present coal position in which there

is envisaged a deficit for the year ending April, 1955, of just over 6,000,000 tons. Should that situation unhappily be realised, the first result would be such a serious depletion of coal stocks that the nation would be unable to face any emergency conditions. The possibility of such a situation during the winter which approaches emphasises once again—if that is necessary—the importance of securing the best use of what the Minister of Fuel and Power described to the conference as " our precious resources of fuel and power." A great deal in that direction is, of course, already being done throughout industry, although no doubt there is more that could be done to encourage the more efficient use of fuel and power. The Sheffield conference took the view that, in the past, the approaches to the subject of fuel efficiency had been generally technical, and that sufficient attention had not been paid to " the psychological approach to the problem." It was urged that where fuel savings involved heavy capital expenditure by small firms hardship was caused, despite the existence of the Government's loan schemes, as the repayment of capital from taxed income, even over a period of twenty years, imposed a burden on the smaller firms. Certainly, an approach to the subject of fuel efficiency which " would ensure that firms really benefited financially from their fuel savings " might be a help in the present pass. Then there is also the question of " alternative fuels," to which the conference gave some attention. The Minister of Fuel and Power, in a message to the delegates, referred in particular to the more extensive use of oil as an industrial fuel, saying that thereby there could be lightened " the heavy burden which the coal mining industry now carries and must continue to carry." Engineers and industrialists are fully cognisant of the contribution which oil is already making, and is likely to make in the future to our national fuel and power resources, but the fact remains that coal continues to occupy a more important place in our economy. The generation of electricity in this country, for instance, remains almost entirely dependent upon coal. In the last six years the British Electricity Authority has commissioned new plant equivalent to 8,500,000 h.p. and it plans to add a further 12,000,000 h.p. in the next six years. The last two winters, fortunately for industry, have been singularly free from power cuts. But only a very small proportion of the new generating plant is designed for oil fuel. Coal is essential ; it is the most precious and plentiful of our natural resources, if only it can be won economically in sufficient quantity for the service of man.

To win that coal is the major part of the " heavy burden " which the coal mining industry carries. The difficulties which the National Coal Board is striving to overcome have been fully publicised. They were again explained by Sir Hubert Houldsworth, the chairman of the Board, at the Sheffield conference, and Sir Hubert also put them, fairly and squarely, a few days before that conference, to his Board's annual summer school at Oxford. That school was attended by representatives of all sections of the coal mining industry. By now, they must have a full appreciation of all the technical, economic and human problems to which their industry must find a solution if it is to function more satisfactorily. The thought does occur to us, however, that a joint session between the Sheffield conference and the Oxford summer school might have been helpful! But whatever the outcome of these recent discussions may be, the immediate coal situation is not encouraging. It is a situation in which production lags while demand increases, and in which coal has to be imported at a financial loss to the Coal Board ; it is a situation which coal consumers, and especially industrial consumers, cannot be expected to accept with equanimity. Restricted capital investment and shortage of technical and other mining manpower are indeed formidable obstacles to the Coal Board's success. But, even when full allowance is made for these obstacles, the coal-using public cannot avoid the conclusion that the rehabilitation of Britain's coal mining industry is a painfully slow process. Nor can it feel at all confident that the end of the fuel " crisis "—which has lasted on and off for eight years—is in sight.

Obituary

H. G. YATES

WE regret to have to record the death of Mr. H. G. Yates, which occurred suddenly at his home at Newcastle upon Tyne, on Wednesday, September 15th, at the early age of forty-six. Mr. Yates was senior designer of the Parsons and Marine Engineering Turbine Research and Development Association, a position which he had occupied with considerable distinction for the last ten years.

Mr. Yates graduated at Trinity College, Dublin, in 1930, with first-class moderatorships in mathematics and physics and was subsequently awarded his M.A. degree. After two years lecturing at the University, he served a student apprenticeship with the English Electric Company, Ltd., at Willans Works, Rugby. In 1933 he joined the turbine department of the company and in 1940 was put in charge of the research work of the department. Mr. Yates was appointed senior designer to Pametrada at its inception in 1944 and was responsible for the design of marine turbine propelling machinery and undoubtedly much of the progress made in marine turbine design and practice during the last ten years may be traced to his influence. He was an associate member of the Institution of Mechanical Engineers, a Fellow of the Institute of Physics, a member of the American Society of Mechanical Engineers and, at the time of his death, was a member of council of the North East Coast Institution of Engineers and Shipbuilders and chairman of the North East branch of the Institute of Physics. Mr. Yates was also a member of several technical committees of national importance. His published work includes two articles which he contributed to the columns of THE ENGINEER. They are " A Universal Resonance Chart," which appeared on October 1, 1943, and " Non-Inductive Wave Analyser Circuits of Constant Q," in the issue of June 7, 1946.

FREDERICK GRANT, Q.C.

WE note with regret the death of Mr. Frederick Grant, which occurred in London on Sunday last, September 19th. Mr. Grant was particularly well known in the iron and steel industry, and at the time of his death was the independent chairman of the British Iron and Steel Federation's executive committee. Mr. Grant, who was sixty-four, was born in Dundee, and was educated at Fettes College and at Oxford University. He went straight from Oxford to service in the first world war, and thereafter spent some years with the steel firm of Bolckow Vaughan and Co., Ltd. Mr. Grant was called to the Bar in 1925, and concerned himself mainly with taxation and financial cases. He was a member of the Monopolies and Restrictive Practices Commission from 1949 to 1952, and in the latter year succeeded the late Sir Andrew Duncan as independent chairman of the British Iron and Steel Federation's executive committee.

275kVA High-Pressure Steam Turbo-Alternator for the Delaware Valley

A SCHEME for a new power station employing very high steam pressures and temperatures has been announced by the Philadelphia Electric Company. The station will serve the Delaware Valley, but the site has not yet been determined. It will house a 275MW Westinghouse turbo-alternator, by far the largest unit yet ordered. The steam-raising plant will be built by Combustion Engineering, Inc., to supply steam to the turbine at 5000 lb per square inch and 1200 deg. Fah., but the operating temperature will be 1150 deg. Fah. initially and will be designed for 8400 B.Th.U. per kWh. The turbine is a tandem-compound, four-cylinder machine, which will operate at 3600 r.p.m., using triple-flow exhaust to the condenser, and double reheat. Both reheats will be to 1050 deg. Fah. All elements of the turbine except the super-pressure portion are of conventional design using ferritic materials. The first, or super-pressure, element will be designed for initial steam conditions of 5000 lb per square inch and 1200 deg. Fah., exhausting at approximately 2400 lb per square inch. The second element combines both high pressure and first reheat pressure turbines in a common casing. The third element combines intermediate pressure and single-flow low-pressure turbine in one casing, and the final element is a conventional double-flow low-pressure turbine exhausting to the condenser at 1·5in Hg. absolute pressure.

Steam will be condensed in a 105,000 square feet, single-pass, radial-flow, Westinghouse condenser. Two pumps, each of 75,000 gallons per minute capacity, will provide cooling water to condense the steam. Nine stages of feed water heating are contemplated, giving a temperature of approximately 565 deg. Fah. boiler feed supply. Westinghouse feed water heaters of approximately 31,000 square feet will heat the feed water.

The alternator will be rated at 352MVA, three phase, 60 c/s, 24kV, 3600 r.p.m. It will be self-ventilated with shaft-mounted fans, and will employ hydrogen inner cooling of rotor and stator conductors, the hydrogen pressure being 45 lb per square in. The alternator will be self-excited and magnetic amplifiers will be used to regulate terminal voltage of the generator.

The boiler will be a Combustion-Engineering-Sulzer " Monotube " steam generator of the super-pressure, " once-through " design, and will use forced circulation. It will be a twin-furnace design with tangential firing and reheat steam temperature control by means of tilting burners.

The maximum design steam conditions for the boiler are 6000 lb per square inch and 1200 deg. Fah. In the first stage of reheat, steam at 1050 lb per square inch will be reheated to 1050 deg. Fah. Conditions for the second stage of reheat will be 250 lb per square inch, 1050 deg. Fah. Of the total heat transferred in the boiler, more than 65 per cent will be absorbed in the superheater and the two reheaters. To accomplish this, radiant wall superheating surfaces will supplement the conventional suspended superheater and reheater sections. Three regenerative air preheaters are to be installed. Alloy steels will be employed in approximately 80 per cent of the tubing.

Conventional combustion controls will be employed to meter fuel and air in proportion to steam demand. Sulzer oil-hydraulic automatic controls will be employed in the steam generator.

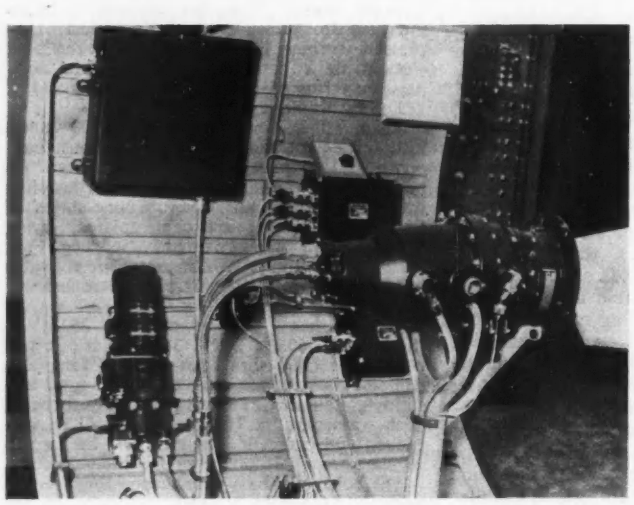
S.B.A.C. Flying Display and Static Exhibition

No. III—(*Concluded from page* 397, *September* 17*th*)

THE need to miniaturise and lighten, which has been so conspicuous a trend in the aeronautical industry in recent years, was again very evident in the static exhibition at Farnborough. Almost throughout the whole range of aircraft and engine accessories it was difficult not to find some new item or development outstanding in some aspect of its design or manufacture. In some important cases security considerations prevent even a brief technical description at this stage, and it is hoped to refer more fully at a later date to a number of developments particularly in the power control and air conditioning equipment category and of other basically rotating or reciprocating accessories. In these categories the need to adopt ever higher shaft speeds in sympathy with the above trends was most striking. One air conditioning equipment has a turbine rotating at about 70,000 r.p.m. and a Messier 4000 lb per square inch hydraulic pump employing reciprocating and rotary stages was shown directly driven by an electric motor at 10,000 r.p.m.

Engine Accessories

Engine accessories serve as a particularly important illustration of the ingenuity in design and precision in manufacture which their lightness and compactness impose on component manufacturers. As an example there is the liquid fuel starter which is likely to supersede electric and cartridge starters, at least in fighter aircraft. These machines labour under highly erosive and corrosive conditions and are subject to severe thermal and mechanical loading. Although exact details are not disclosed, speeds of the order of 50,000 r.p.m., component temperatures approaching the fuel decomposition temperature of 1200 deg. Cent., and hypersonic gas velocities are believed to be involved. The size of a typical installation can be gauged from our illustration, the foremost item being the actual engine mounted starter unit weighing about 55 lb. Yet such units are capable of developing over 400 peak horsepower in the first three or four seconds of the 10-second starting cycle.



Mono-fuel gas turbo-starter showing the engine unit and associated equipment]

One of the principal reasons for developing a turbine-driven starter motor for gas turbines is the need in fighter aircraft to start the engine independently of ground services in ten seconds. Petrol engines presented little difficulty and the largest of them were started by electric motors developing from 3 h.p. to 5 h.p. In the case of gas turbines the peak horsepower required to accelerate the rotor to 2000 r.p.m. in two seconds is directly proportional to its moment of inertia (neglecting compression work) and it has been shown that the larger prime movers having a moment of inertia of 450 lb-ft² would require a peak starter horsepower of 550 h.p. Where the ten-second start is not required an electric motor developing no more than 20 h.p. to 30 h.p. can effect a start on a large turbo-jet engine in about thirty seconds.

The first of these turbine starters employed a single cartridge for each start. There were two factors, however, mitigating against its further development. With several aircraft, because of the method of engine installation, it became extremely difficult to reload the cartridge chamber. Furthermore, because of the starter power/inertia relationship, the size of a cartridge chamber would become disproportionately large.

Two of the liquid fuel starters which have been developed to overcome these difficulties use a monofuel known as iso-propyl nitrate, developed by Imperial Chemical Industries. This fuel decomposes without an oxidant at about 1200 deg. Cent. With these units fuel can be delivered to the combustion and turbine element on the engine by pumps and control equipment mounted remotely. This portion of the starter attached to the turbine is smaller than its solid fuel counterpart and the "all-up" weight, including the pumping unit and all control gear, compares favourably when taken on the basis of three available starts. On multi-engine aircraft the comparable weight can be even more reduced by the use of a single pumping unit to all the engines. It has the advantage also of being able to continue a protracted start for a limited period.

The unit designed by the British Thomson-Houston Company, Ltd., establishes the necessary conditions of pressure and temperature for sustained decomposition of this fuel in an auxiliary reaction chamber by the use of a heater unit which virtually has the effect of boiling the initial supply of fuel.

Experiments showed it to be uneconomical of battery energy to initiate reaction in one stage with the large flow rate involved, and two chambers were therefore used, an auxiliary and a main. In the auxiliary chamber the reaction is initiated electrically by a heater and the high-temperature exhaust is fed through a nozzle to the main chamber, where it sets off the main reaction. Where flow rates much greater than 5 gallons per minute are necessary it is expected that a three-stage unit may prove advantageous. Present knowledge suggests a factor of five for the main inflow rate for each additional chamber, starting with the present economical maximum in the auxiliary of 1 gallon per minute.

The starter normally operates with a main chamber pressure of about 800 lb to 1000 lb per square inch, and a great advantage of this relatively high pressure is that it leads to a small overall size of the reaction chamber. This may be of paramount importance when the starter has to be accommodated in a very restricted space such as in the nose bullet of an aircraft engine.

In operation the start button commences a sequence timing mechanism which first of all energises the heater in the auxiliary chamber for two-and-a-half seconds, after which the on/off valve is opened in the fuel supply line to the spray nozzle in the auxiliary chamber. As decomposition commences, the pressure immediately rises and the exhaust gas conditions the main chamber for the main reaction. Fuel is admitted here after a predetermined interval, after which both lines are kept open for the full time required to bring the aircraft turbine engine up to its self-sustaining speed. Once this is reached a centrifugal switch closes the fuel valves and resets the timing mechanism. It will be noted that this system requires no scavenging of the combustion chambers before firing, as the monofuel decomposes without the aid of oxygen.

The control unit comprises two electrically operated contactors, the sequence timer and two small relays. The two contactors are for switching the supply to the heater and pump motor, while the timer controls the correct sequence and timing of the operations. The relays are part of the safeguarding system described later. A control valve incorporates a relief and two selector valves. It holds the fuel pressure approximately constant and, initially, when only the auxiliary chamber is running, by-passes the excess fuel back to the fuel reservoir. The electrically operated selector valves control the fuel to the main and auxiliary chambers. The throttling valves are fitted to each fuel line to prevent excess flow to either chamber before the reaction pressure rises. They are operated automatically by the pressure difference between their respective chambers and the atmosphere. Non-return valves are fitted in each fuel line to prevent any sudden pressure surge from passing up stream.

This unit has proved to operate entirely satisfactorily on a test rig of equivalent inertia to the largest engine to date, and the peak power required to start such an engine in the short time available is in the neighbourhood of 300 b.h.p. Satisfactory cold starting tests have been carried out at −40 deg. Cent. on an aircraft turbine engine having a moment of inertia of 450 lb per square foot at speeds up to approximately 2000 r.p.m.

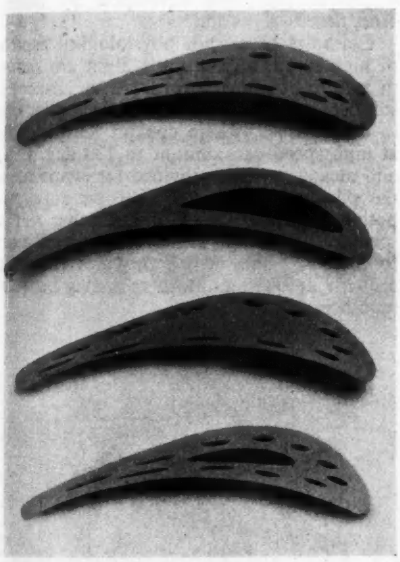
A fundamental difference between this starter and that illustrated here, made by the Plessey Company, Ltd., is the method used for initiating the decomposition of the fuel. In this unit the combustion chamber is charged with a mixture of fuel and of pressure air supplied by a blower and ignited by a high energy ignition plug. When the critical temperature and pressure conditions for fuel decomposition have been attained the air supply is cut off. Gases expand through four convergent divergent

nozzles on to a single stage Nimonic impulse wheel and the drive is taken through a single stage epicyclic reduction gear having a maximum output of 12,000 r.p.m.

Rotax, Ltd., has also developed both cartridge and liquid starters and in our issue of December 22, 1950, both the Plessey and the Rotax prototype cartridge starters which were then being developed were described. Rotax has now, however, developed a fuel/air starter which is already in use in Service naval aircraft. This exhibit represents the latest development in liquid gas-turbo starters. It was designed to use the same fuel as the engine it is to start. Apart from this very important consideration there is the advantage that the effluent can be exhausted freely. All the other fuel starters have a highly corrosive and combustible exhaust which not only determines their short life but has to be specially ducted from the aircraft. Whilst the unit only makes a small demand on the electrical system it requires a pressure vessel and an air pump.

The installation consists of a turbo starter and associated electrical, air and fuel systems. The electrical system uses the aircraft 24V supply and includes an ignition control unit, which, when operated by the starter button, energises the starting ignition system and opens fuel and air solenoid-operated valves.

Compressed air at 3000 lb per square inch is contained in a fibreglass spherical storage bottle, 13in diameter, incorporating the starter air valve. On being opened, air at high pressure passes to an air-fuel servo unit, which reduces the pressure and controls the supply of air to the starter ; this unit also contains a fuel reservoir primed from the aircraft main fuel system. The fuel valve is mounted on the starter and, when opened, fuel under pressure is fed to the starter from the servo unit.



Some typical Nimonic aerofoil sections successfully extruded showing different configurations of cooling passages

The starter itself is a small gas turbine of conventional design incorporating the usual features of combustion chamber, nozzle housing and a turbine wheel geared down to drive the main engine. During combustion a pressure switch on the starter operates when the combustion chamber pressure reaches approximately 80 lb per square inch, breaking the starter ignition circuit and holding open starter fuel and air valves ; when maximum speed is reached these valves are closed by a governor switch incorporated in the starter.

The air storage bottle is charged by a lightweight compressor used in conjunction with air drying equipment. When self-contained starting is not an operational requirement and no drying equipment or compressor is included in the system the bottle can be charged from an external air supply which must be dried to a dew point not higher than −55 deg. Cent.

The starter unit consists of a small single-stage gas turbine with a combustion chamber constructed of sheet metal and a turbine wheel with buckets of heat-resistant alloy welded to a stainless steel disc. Combustion gases pass through nozzles which are pressed into a nozzle housing and brazed, the housing itself also being brazed to the combustion chamber.

Located in the combustion chamber is a combined fuel metering nozzle and atomiser, through which fuel from the reservoir enters the chamber. At one end of the combustion chamber is fitted an air nozzle, which is so designed that the mass air flow into the chamber from the air-fuel servo unit remains constant and when mixed with the metered and atomised fuel, the fuel air ratio obtained is chemically correct for ideal combustion. The mixture is ignited by a sparking plug fitted in the combustion chamber and energised by a booster coil in the ignition control unit.

The ignition control and air-fuel servo units can be integral with the starter or they can be remotely installed where the starter is to be accommodated in a restricted space, such as the engine nose fairing.

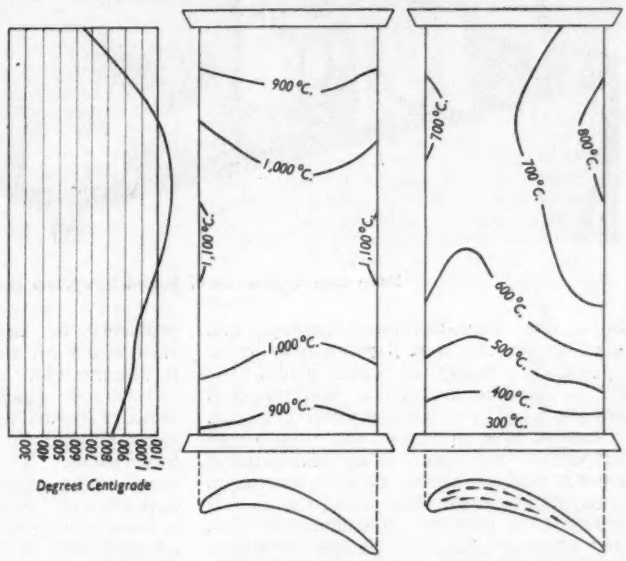
The compressor, which is used to charge the air vessel, is not without interest. It is a four-stage radial unit, intercooled between stages. Output is 4 cubic feet per minute free air at a maximum rated delivery pressure of 3000 lb per square inch. It weighs 10·5 lb. Input is provided by a bleed from the main engine compressor, a reducing valve controlling line pressure at 14·7 lb per square inch, allowing sea level performance to be maintained at altitude.

Cooling between stages is by a fan which forces air over the cylinders and the interconnecting heat transfer tubes ; the fan need not be fitted provided a supply of blast air is available.

The compressor is suitable for use with an engine-driven gearbox or it can be fitted with hydraulic motor or air-turbine drives. Air leaving the compressor passes through a water separator and an air drier before entering the air storage bottle ; it is essential that the air be dried to a dew point not higher than −55 deg. Cent. to prevent freezing of the starter valves.

The weight of the actual starter unit is 50 lb, the air-fuel servo unit weighs 12 lb, and the air bottle assembly, full, 27 lb, bringing the weight of the whole assembly to 122 lb. It is able to accelerate a rotor of 450 lb-ft² to 2000 r.p.m. in 3·9 seconds, the average torque being 160 lb-ft. Air consumption is 1·1 lb per second, and it uses 0·27 lb of fuel per start.

Air-Cooled Blades.—As the use of air appears to be the least complicated method of blade cooling, a considerable amount of production development work has been undertaken by Henry Wiggin and Co., Ltd., to produce blade sections with axial air passages, a section of which was shown. Casting and sintering have both been tried for the production of sections with a large number of small cooling passages. However, in comparison with wrought materials of the same composition, castings suffer the disadvantage of being less uniform in properties, while the art of sintering has not yet been developed sufficiently to permit adequate mechanical properties to be obtained. As new alloys have been added to the Nimonic series, there has been a corresponding reduction in the difference between the operating temperature, at which the alloy must be stiff, and the forging temperature, at which it must be reasonably malleable. A stage may therefore be reached when alloys for still more onerous service cannot be forged economically by normal techniques. The extrusion process extends the range of composition of alloys which can be commercially worked by breaking down the coarse structure of the cast ingot and thus improving forgeability so that ordinary hot—and cold—working operations can be used to give the desired final dimensions.



Effect of air cooling on the operating temperatures of stator blades and the heat distribution

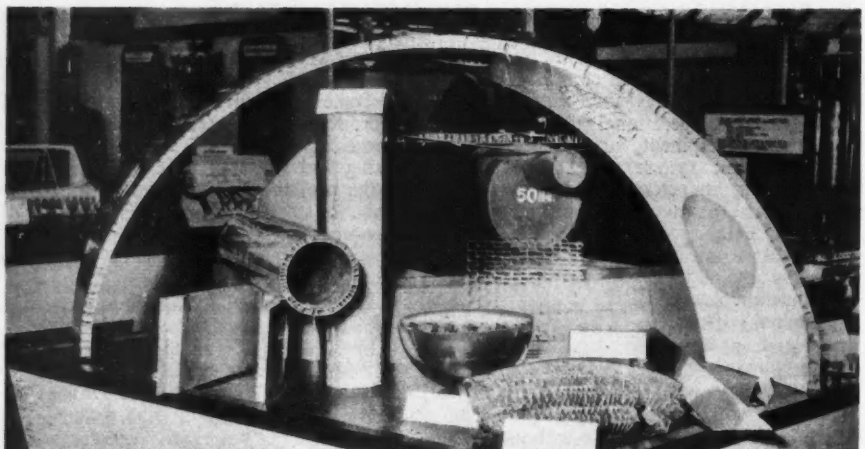
For some time the Zenith works of Henry Wiggin and Co., Ltd., have been producing Nimonic alloy aerofoil sections by hot extrusion and subsequent rolling. Work is now sufficiently advanced to enable a wide range of such forms to be successfully extruded, including those containing various configurations of cooling passages, (as illustrated), the holes being drilled before rolling.

It appears to be economically possible to produce cooled blade sections by this process, with passages limited in number, size and shape only by the operations involved in machining the original billet.

The drawing above gives some impression of the effect of air cooling on the operating temperatures of stator blades and on heat distribution. Cooled blade sections are currently being produced in Nimonic 80A and Nimonic 90.

Titanium

Several firms are now experimenting with titanium alloys and William Jessop and



Some aero applications of bonded honeycomb skins

Sons, Ltd., Firth-Derihon Stampings, and Garringtons, Ltd., were showing some typical applications, mostly compressor blades. As far as could be ascertained, however, it is not yet being used in any aircraft or engine.

Jessops have announced that it is to take supplies of high-grade sponge and produce from it titanium and its alloys in sizes large enough to meet the demands of the aircraft industry for forgings for compressor discs and other components. Blades, or bright bar for the production of blades, will also be available.

Arrangements have been made to obtain technical aid from one of the largest American producers of titanium, and this will enable production of high-grade alloys to be started in Sheffield. It is expected that initial supplies will be available by the end of 1955.

Research work in the Jessop laboratories has been going on for two years, and already some attractive alloys have been developed for operation at elevated temperatures. For instance, a few experimental blades have already been made in an alloy which shows a strength of over 30 tons per square inch at 400 deg. Cent. for a creep strain of 0·1 per cent in 100 hours. This is appreciably better than any alloy at present available to the aircraft industry either in America or Britain. Consideration is also being given to the problems of the modulus temperature relationship for those parts where stiffness is all-important.

Air-cooled suit to promote evaporation of perspiration

Electronic Equipment—The British radio industry showed a wide and varied range of electronic equipment for airborne and ground installations. The latest Ekco airborne search radar equipment shown, as installed in the Bristol " Britannia " and other aircraft, is mainly designed to give the pilot warning of dangerous cloud formations.

Taking full advantage of modern miniaturised valves, components and batteries, radio equipment has been developed which greatly increases the airman's chance of survival and rescue at sea.

The latest equipment is " Talbe," a talk-and-listen beacon equipment made by Burndept, Ltd., Erith, Kent. It operates with the standard v.h.f. communication and homing apparatus fitted in civil and Service aircraft.

A specially designed belt to be worn by each member of the aircrew contains a super lightweight and miniature v.h.f. beacon and R/T transmitter. The beacon equipment radiates a continuous distress signal which can be recognised and received at distances up to 60 nautical miles by any aircraft flying at 5000ft or higher.

When one of the rescue aircraft is within about 20 miles of the airman he can switch to R/T and talk with the pilot for at least half an hour. The battery weighs less than 29oz and yet supplies power to operate the beacon for six to eight hours.

Distance measuring equipment exhibited by Ferranti shows on a meter dial in the aircraft the exact distance in miles from a ground beacon, with an accuracy of 4 per cent. As this device operates in the 1000 Mc/s band, it is not affected by rain or cloud conditions. For the Murphy " D.M.E.," which has a range of 200 miles at an altitude of 20,000ft, a new remotely controlled monitor has been introduced for the ground beacon. The airborne portion of the " D.M.E." is specified for installation in all " Comets " Mark II and III, as well as the Bristol " Britannia."

A. C. Cossor, Ltd., exhibited a secondary surveillance radar system which provides an air traffic controller with a positive method of identifying all aircraft fitted with " Transponder " equipment within line of sight at distances up to 150 nautical miles and at altitudes up to 50,000ft. The controller has only to request the pilot to adjust the " Transponder " to radiate a certain number of pulses when triggered by the airfield's radar in order definitely to identify the aircraft.

One of the more interesting airborne communication instruments is the Marconi " AD 307," 130W multi-channel transmitter/receiver. Basically, this provides 200 crystal controlled channels, but by substituting an alternative drive circuit 44,000 channels are provided in the 2–24 Mc/s frequency range.

Remote control facilities are entirely automatic and tune all circuits, including the aerial tuning unit.

An innovation in intercom equipment is the Mullard amplifier in which germanium transistors are used instead of valves.

Precision electronic measurement of engine speed with accuracies up to 0·03 per cent, the result given in revolutions per minute, is provided by a new Plessey instrument.

A high-power 100W, 100-channel R/T airborne communication equipment operating in the h.f. range of 2·8–18·1 Mc/s has been developed by Standard Telephones and Cables especially for long-distance air transport operators. This company also showed its latest frequency-modulated radio altimeter. Operating in band 4200–4400 Mc/s per second, it can accurately measure the height of an aircraft down to 2ft.

G.E.C. showed a new " FM " radio altimeter. The presentation consists of single pointers with one revolution per 1000ft. Preset height may be selected manually on a limit height unit and indicator. The limits provide warning when flying above or below any preset height.

Some Other Developments.—Another of our illustrations, taken on the Avro stand indicates the development of a sandwich construction using a very light honeycomb core bonded between thin sheet panels. The bonding technique has been developed by A. V. Roe, Ltd.

Examples of certain physiological aspects of high-speed, high-altitude flight are shown in two other illustrations. The air-cooled suit becomes necessary in low-level operations in desert areas, where cockpit temperatures at high speed can amount to 130 deg. Fah., and means must be provided for evaporating the pilot's perspiration. The air supply is both cooled and dried. The other suit is pressurised for high-altitude flight as distinct to the " g " suit, which provides relief for centrifugal loading. Both suits may be worn together.

Pressurised suit, head gear and oxygen mask for use at high altitudes

Connah's Quay Power Station

Connah's Quay power station on the Dee estuary was opened by Lord Citrine, chairman of the British Electricity Authority, on September 16th. The installed plant in the first stage of this station consists of two 30MW turbo-alternators taking steam from p.f. fired unit boilers of 300,000 lb per hour capacity at 625 lb per square inch and 865 deg. Fah. When two other equal stages have been completed the station capacity will be 180MW. From the civil engineering viewpoint the station is interesting, in that it is built on reclaimed saltings, the general level of which was raised 8ft by pumping sand across the estuary. Further reclamation for development will be effected over the next twenty years by pumping boiler ash and dust over low-lying land to the north-west of the 132kV substation.

CONNAH'S QUAY power station which was opened on Thursday, September 16th by Lord Citrine, chairman of the British Electricity Authority, is the outcome of a scheme initiated by the Chester City Council before nationalisation of the electricity supply industry. The original intention was to replace the existing station at Queensferry on the Dee estuary by building a larger station of about 60MW capacity on the site of the old station. When the project was taken over by the B.E.A. on April 1, 1948, it was decided that a much larger station would be needed to satisfy the growing electrical demand in North Wales.

A station with an ultimate capacity of 180MW was then envisaged, the installation to be completed in three stages, consisting of 60MW in 1953, an additional 60MW in 1955, and a third 60MW in 1957. It was the first of these stages that was opened by Lord Citrine last week. Since the Queensferry site could not house a station of this size aerial and ground surveys were undertaken, as a result of which a site of about 200 acres about a mile north-west of Connah's Quay was obtained. It is bounded on the north by the River Dee and on the south by the Chester-Holyhead railway line.

The virgin site consisted mainly of tidal saltings at about 14ft above O.D. level and at spring tides it was completely covered, apart from a small rock outcrop at the entrance to the site which was approached by a cart track from the main Chester-Rhyl coast road. Trial borings showed a rock formation dipping north-east from the rock outcrop to depths of 12ft to 20ft along the railway embankment and to 50ft along the riverside boundary.

To accommodate the power station, cooling towers, outdoor grid substation and coal store, it was necessary to reclaim an area of about 70 acres of salt marsh. Reclamation began on March 22, 1950, with the building of a series of bunds around the site, the bunds next to the river being protected against erosion with willow mattresses and stone. Four inches of topsoil were removed from the saltings within the bunds and were stored. Sand was then pumped into this area from a suction dredger anchored in an inland lagoon on the opposite bank of the river. This dredger pumped a mixture of sand and water at a rate of about 4500 tons per hour through a 26in diameter pipe about a mile long. The water was drained away through pipes provided in the bunds, leaving the sand to settle. In this way a total of about 800,000 tons of sand was deposited to an average depth of 8ft in nine weeks and then the 4in of topsoil were relaid, making a general site level of 22ft above O.D. by August 1, 1950, when reclamation was completed.

Most of the structures are carried on 14in square precast piles between 15ft and 30ft long. For the buildings the piles are spaced at about 3ft 6in and the floors are of beam and slab construction spanning the pile caps; the bottom of the cooling tower pond is a flat slab spanning single piles spaced at 13ft centres. The turbo-alternator blocks are of reinforced concrete separated from the operating floor by an expansion joint to avoid transmitted vibration. The main building is steel framed and the walls are mainly of 14in brickwork, reconstructed stone being used for the door and window surrounds and parapets. Most of the windows and the continuous lantern light to the turbine bay are of "Lenscrete" glass-in-concrete construction. The roofs consist of hollow precast reinforced concrete blocks with 1in cork insulation and felt and asphalt waterproofing.

As illustrated here there are two chimneys, each 300ft high and supported by 58ft high concrete stools clad in brickwork. The chimney shafts are sixteen-sided structures of reinforced concrete lined with 4½in "Nori" acid-resisting bricks.

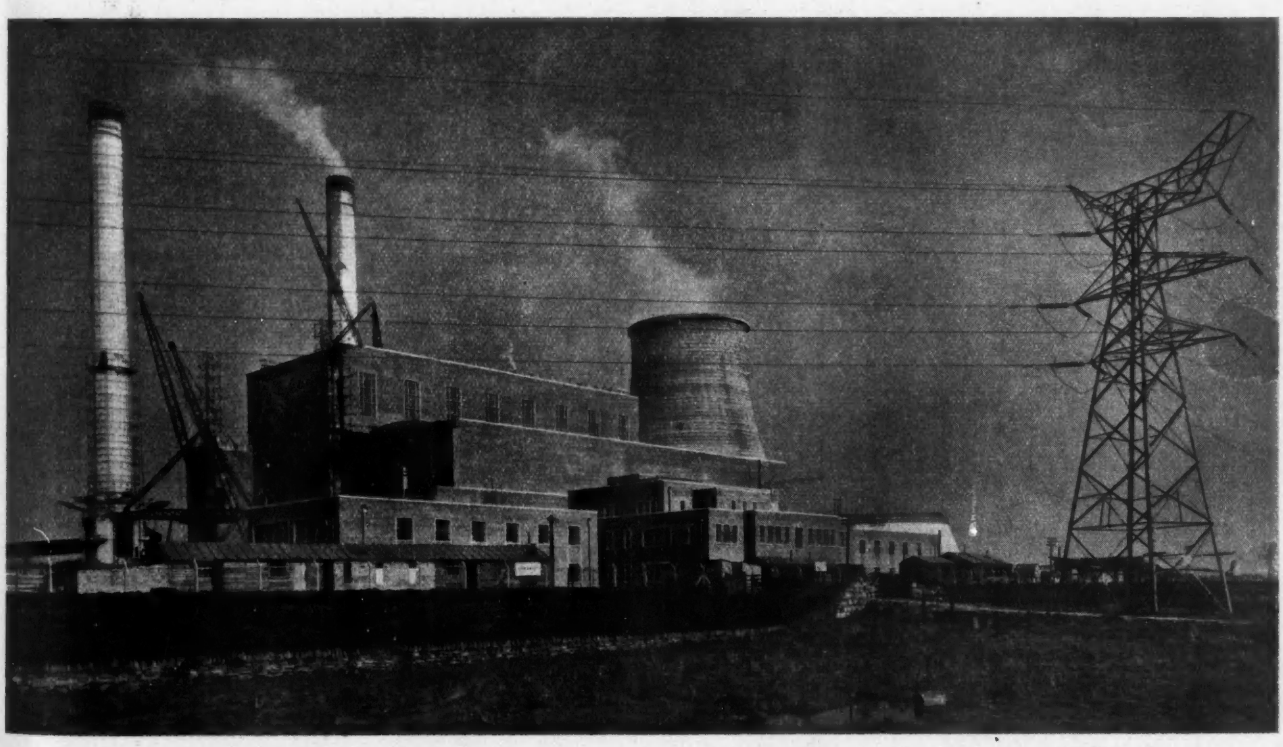
Most of the coal requirements (10,000 tons per week for the completed station) will be railborne but provision is made for accepting deliveries of coal by road. Railborne coal will be handled in sidings associated with two wagon tipplers, each capable of handling and weighing 250 tons per hour in 20-ton trucks. At the tipplers the wagons are discharged into a common hopper which feeds a belt conveyor system delivering coal at 250 tons per hour to the coal junction house, whence the coal can be fed either to the boiler house bunkers or to the coal storage area where it is distributed by bulldozers. Coal is reclaimed from stock by bulldozing to either one of two hoppers and is then carried to the junction house by a belt conveyor system. From the junction house two independent belt conveyors take the coal into the boiler house where it is distributed by two shuttle conveyors which serve the three hoppers of each boiler bunker.

Boiler Plant

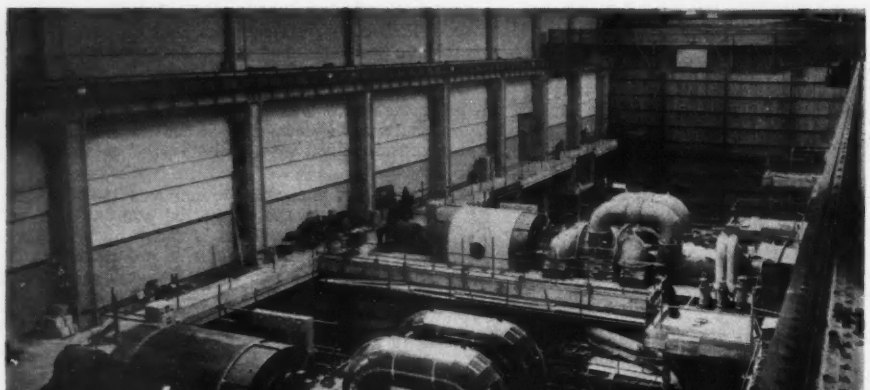
Three "Lopulco" mills fed by chutes from each bunker pulverise the coal for each boiler and the coal is dried during the grinding process by hot air which also serves as primary air to the burners. Each mill has an exhauster fan to deliver the coal-carrying air to the burners. In each corner of the boiler combustion chamber there is a p.f. fired burner box fitted with three burners arranged for tangential firing to give good turbulence in the furnace.

Steam is raised in "Lopulco" tri-drum boilers each with a capacity of 300,000 lb per hour at 625 lb per square inch and 865 deg. Fah. In the complete installation there will be six such boilers, two of which are in service.

The superheater is designed to maintain a final temperature of 865 deg. Fah. within ±15 deg. Fah. by means of tilting burners over a load range of 80 to 100 per cent of the boiler rating. Each boiler is provided with a welded economiser arranged in a single bank of horizontal elements and with plate air heaters.



Connah's Quay power station seen from the west. Three cooling towers will serve the 180MW station when completed



Turbine room at Connah's Quay power station. Two of the six 30MW turbo-alternators are installed

Automatic boiler control is exercised by Bailey equipment regulating the supply of fuel, combustion air, furnace pressure and steam pressure. All the main dampers on the boiler are remote controlled by Lockheed hydraulic mechanism from the boiler unit control panel, from which the starting and stopping of the boiler auxiliary motors are also controlled. Each boiler is served by two f.d. and two i.d. fans, the f.d. intakes being above the boilers to take advantage of reclaimed heat. Flue gases from the boiler are passed to a Sturtevant electrostatic precipitator which is in two sections, either one of which can be shut down for maintenance.

Ash and dust are discharged from the hopper below each boiler into a system of sluiceways which run along the length of the station below the hoppers. The main sluiceway is discharged into a swirl pit 15ft below ground level. This pit is of concrete and it has a chrome alloy steel liner provided with three outlets suitable for the suction pipes of three ash slurry pumps. Each of these 150 h.p. pumps can discharge slurry at 3000 gallons per minute through a 12in pipeline to the top of an open culvert (known as an ash launder) 36ft above ground level. From this point the ash launder falls at a slope of 1 in 65 to the nearest corner of the initial ashing area. The slurry flows down the launder and is discharged on this ashing area, where it settles out and the water is returned through a controlled outlet to the river. It is estimated that this initial ashing area will suffice for about two years. The delivery end of the launder can extend to a second ashing area, but it is anticipated that a further swirl pit and booster pump will have to be installed to take ash to the boundary of the saltings which have been acquired for ash disposal purposes. A point of interest about Connah's Quay power station is that sufficient low-lying land is available beyond the substation, to the north-west, to accommodate the disposal of ash and dust by pumping for an estimated period of twenty years. This dumping will recover tidal saltings for development.

Turbo-Alternators

The complete turbo-alternator installation will consist of six 30MW sets with an economic rating of 24MW. Each turbine is associated as a unit with one of the boilers and two such units are at present installed. The turbines are twin-cylinder reaction machines running at 3000 r.p.m. with stop-valve steam conditions of 600 lb per square inch and 850 deg. Fah. On the h.p. rotor there are forty-eight rows of blades and on the l.p. rotor there are twelve rows of blades. From the last stages of the low-pressure cylinder the steam is exhausted to a three-pass surface condenser designed for a vacuum of 28·7in of mercury when the turbine is operating at its economic continuous rating, the cooling water inlet temperature being 65 deg. Fah. and the outlet temperature being 87·5 deg. Fah.

Each of the two electrically driven extraction pumps is capable of handling the full quantity of condensate. Two 100 per cent duty steam-operated multi-stage air ejectors are provided for maintaining vacuum in the condenser, together with one single-stage quick-start ejector which will create a vacuum of 20in of mercury in the condenser in four minutes.

There are four feed-water heaters and they utilise bled steam from the turbine at pressures of 154 lb, 58·2 lb, 15 lb and 5·1 lb per square inch absolute, the conditions for a maximum load of 30MW. The feed water leaves the No. 2 high-pressure heater at 345 deg. Fah.

For each boiler turbine unit there is an electrically driven feed pump to deliver 330,000 lb of water per hour against a pressure of 880 lb per square inch. A steam-driven feed pump for the same duty is installed with each unit as standby and is arranged to start automatically at a predetermined reduction in the feed pressure delivered to the boilers. The exhaust steam from the turbine is normally passed into the No. 2 low-pressure heater of the associated main turbine. Relief valves are fitted, however, to exhaust to atmosphere.

The boiler feed pumps are sited between the second and third feed heaters. A shunt deaerator is fitted into the feed system to ensure a supply of deaerated water for make-up. The instruments provided with the turbo-alternator are mounted on a unit control panel which is supplied under the boiler contract.

The alternator is a three-phase machine with a direct-driven exciter. Cooling is by a closed air system, circulation being provided by two motor-driven fans, each of which is capable of providing the cooling requirements for an alternator output of 60 per cent M.C.R.

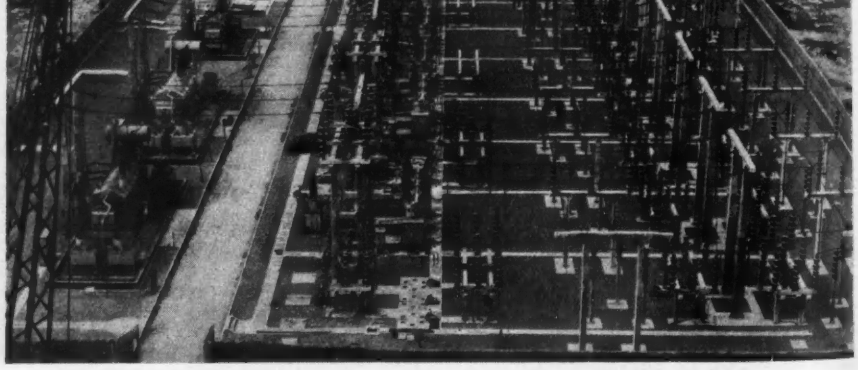
Circulating Water

Circulating water for the condensers will be handled by three r.c. cooling towers, one of which is completed, as shown in the photograph on page 429. Each tower is designed to cool 2½ million gallons of water from 87·5 deg. Fah. to 70 deg. Fah. and is fitted with spray eliminators and de-icing equipment. The towers are built on a common pond, which can be divided to allow one-half of any tower to be operated while the other half is being cleaned. Because of the possibility of high concentrations of sulphates being present in the pond sulphate-resisting Portland cement was used for the construction of the towers and the pond. The towers are 250ft high.

From the ponds the cooling water is taken by twin, open, rectangular culverts to the c.w. pump house, which will be equipped with six pumps, each of 21,000 gallons per minute capacity, discharging into twin ducts which run underneath the length of the turbine house.

Make-up water for the cooling towers and for the ash sluice water are taken from the River Dee through two 20in pipes carried in a piled dolphin 35ft from the bank. Three 4000 gallons per minute vertical pumps draw this make-up water at low ebb tides when the salt content of the main channel is at a minimum.

A chlorination plant is installed to eliminate slime-forming growths in the condenser tubes and prevent the growth of marine organisms in the circulating water system. This equipment has a maximum capacity of 3000 lb of chlorine for each twenty-four hours' continuous rating and is designed to operate intermittently under the control of a central programme clock. The chlorine injector is operated by water under pressure delivered from a booster pump, the water being drawn from the circulating water return ducts. From the injector of the chlorinator, where the chlorine is intermittently mixed with the operating water, rubber-lined piping conveys the solution to the points of application immediately on the inlets to each condenser. To



132kV grid substation at Connah's Quay equipped with bulk oil circuit breakers

govern the application of chlorine to each generating set a hydraulically operated valve is installed on the connection to each condenser, the valves being controlled from the main central electrical programme clock.

To prevent corrosion and scale formation a complete water treatment plant is being installed. Water taken from the town main is treated in a mixed-bed "Deminrolit" plant in a separate building on the east side of the main station building.

Each generator is connected to the 132kV grid system through a 36MVA, 11·8/132kV generator transformer installed in the outdoor substation; these transformers can be seen on the left of the accompanying illustration. The transformers are cooled by forced oil circulation and air blast, with two 100 per cent coolers for each equipment. On-load tap changing is provided and inhibitors will be added to the oil in certain of the transformers so that a study can be made of the effect of the various inhibitors.

Bulk-oil switchgear with a rated rupturing capacity of 2500MVA constitutes the main switchgear. Provision is made for six generator switches, two station transformer switches and eight feeder switches, together with the usual busbar coupler and bus section switches. This switchgear can be seen in the centre of the photograph of the substation.

Electrically each turbo-alternator and boiler is unit-operated, the essential supplies being drawn from unit transformers directly connected to the alternators. A compound situated under the turbine house annexe accommodates the auxiliary transformers, Supplies to non-essential auxiliaries and other station loads are derived from naturally-cooled 5MVA, 132/3·3kV transformers in the 132kV compound.

A cable tunnel carries all the main and multicore cables between the station and the compound. Generally the cables are paper insulated and lead-covered but much of the cabling near the boilers is mineral insulated and copper clad.

The control panels and the panels carrying the station protective relays are installed in separate adjoining rooms in the centre of the administrative block. Natural lighting of the control room is provided by a laylight with roof lights. Artificial lighting comes from cold-cathode tubes mounted above the laylight.

The development and the detail design of Connah's Quay power station was carried out by the former Merseyside and North Wales Division which is now merged with the North Western Division of the B.E.A. Messrs. Mouchel and Partners are the civil engineering consultants for the power station and the river intake works.

Main Contractors

The following is a list of the main contractors :—

Civil Engineering.—Reclamation, Westminster Dredging Company, Ltd.; pile foundations, main and ancillary foundations and permanent roads, cooling towers and c.w. conduits, The Yorkshire Hennebique Contracting Company, Ltd.; superstructure, south block, and ancillary buildings, J. Gerrard and Sons, Ltd.; structural steelwork, Francis Morton and Co., Ltd.; ferro-concrete chimneys, Tileman and Co., Ltd.; railway sidings, T. Summerson and Co., Ltd.

Mechanical Engineering Plant.—C.w. make-up pumps, valves and pipework, Gwynnes Pumps, Ltd.; electrically driven boiler feed pumps, The Harland Engineering Company, Ltd.; coal handling plant, ash and dust handling plant, boilers and p.f. equipment, International Combustion, Ltd.; turbo-alternator sets, condensing and feed heating plant, C. A. Parsons and Co., Ltd.; water treatment plant, The Permutit Company, Ltd.; low pressure pipework, Shaw Petrie, Ltd.; c.w. pumping equipment, Sigmund Pumps, Ltd.; high pressure pipework, John Thompson (Wolverhampton), Ltd.; chlorinating plant, Wallace Tiernan, Ltd.; 65-ton overhead travelling crane, Clyde Crane and Engineering Company, Ltd.

Electrical Plant.—Main switchgear, Ferguson Pailin, Ltd.; generator and station transformers, C. A. Parsons and Co., Ltd.; auxiliary switchgear, A. Reyrolle and Co., Ltd.; auxiliary transformers, English Electric Company, Ltd., Bonar Long and Co., Ltd.; cabling, British Insulated Callender's Cables, Ltd.; batteries and rectifiers, Tudor Accumulator Company, Ltd., Hackbridge and Hewittic Electric Company, Ltd.

International Conference on Coastal Engineering

AN international conference on coastal engineering has recently been held at Grenoble, France, from September 8th to 11th; it was organised by the council on wave research of the University of California, being the fifth of a series of annual conferences arranged by that body. The first conference was held at California in 1950, and the other conferences were all held in the United States. The papers presented at the fifth conference included contributions from Great Britain, the Netherlands, the United States and Portugal. The French contribution was a particularly strong one, and included a number of papers from the staffs of the Laboratoire National de Chatou, the Laboratoire Dauphinois d'Hydraulique, and the Laboratoire de Mecanique des Fluides de l'Ecole Nationale Supérieure d'Electrotechnique et d'Hydraulique de Grenoble.

Theory of Waves.—Various aspects of contemporary research on wave action were described during the course of the conference, including descriptions of apparatus devised in hydraulic laboratories for this class of work, as well as explanations of the work itself. Papers devoted to the study and measurement of waves, principally in the laboratory, formed the largest contribution to the conference. One such study (Kravtchenko and Santon) concerned transverse oscillations in a wave canal; extremely precise recorders were used to study a "parasitic" transverse clapotis having a period equal to two-thirds of the principal wave motion. The reflection coefficient of an obstacle—in this case an inclined plane—subjective to wave action was also investigated in another paper (Greslou and Mahe) devoted to laboratory work; the results were plotted as a graph of reflection coefficient for a wave acting normally, against the slope of the inclined plane and the camber of the wave. Such a graph, it is thought, would be of use in estimating the desired strength of maritime structures which have to resist waves, and in studying navigational and berthing difficulties.

On the more practical side of this research there was a paper by Gille, entitled "Wind and Maximum Wave Height," which summarised the known relationships between wind and wave conditions in the open sea. Careful observations were confirming waves of 80ft to 100ft in height, it was stated, such exceptional heights being explained by the superposition of two undulations of similar period. There are notes in the paper on the relation of this work to the design of ships' structures, and the strength calculations normally made are commented upon. One of the instruments for full-scale work, with applications to engineering rather than research, is the "integrator" described by Wemelsfelder. This instrument is intended to be float-operated, with continuous recording, measuring the total vertical movement of the water surface and the number of waves from the number of reversals of direction of the float.

Coast Protection and Littoral Drift.—A number of sea defence works are described in papers to the congress, and the 1953 storm and surge has, as might be expected, resulted in contributions describing the Dutch and British reactions to that disaster. The papers on coast protection, however, concentrate in several cases on the more basic problem of the movement of materials by the sea, and on the study of littoral drift. Some general remarks on littoral drift, in which the difficulty and expense of observations from nature is pointed out, are given in a paper by Sauvage de Saint Marc and Vincent. This paper goes on to consider some aspects of the development of sandbanks and the evolution of littoral spits and tombolos. In his paper "Migrating Sand Waves or Sand Humps," Bruun points out that there cannot be much difference physically between the transport of sediment in rivers and the drift along sea shores, apart from the littoral zone with its extremely complex conditions. The major part of the paper deals with migrating sand "waves" or humps along the North Sea coast of the Jutland peninsular, and with the observations made on them. A practical application of the study of littoral drift is attempted in the paper "Using a Breakwater for Beach Protection," by Delage. Results are given of the study of the effect of a breakwater on the profile of a beach, and on the layout of an immersed breakwater intended for beach protection. In the latter case it is concluded that it is better to build a structure that is not efficient enough, rather than the contrary; otherwise there may be, in some cases, a dangerous erosion of the beach at one end of the structure.

Other papers on the subject of coast protection were :—"Sea Defence Problems: the Success and Failure of Some Structures," by Dreyfous-Ducas; "Fundamentals of Coast Erosion," by R. R. Minikin; "Sea Defence Works on the Atlantic Coast Between the Loire and Gironde," by M. Blondeau and M. Baste; "Observations on the Filling of the Anse de L'aiguillon," by F. Verger; "Bitumen in Coastal Engineering," by Van Asbeck; "Some Sea Defence Works in England," by C. H. Dobbie; "The Rebuilding of the Eastern Dyke of the Harbour of Dunkirk," by V. Le Gorgeu and R. Guitonneau; and "The Dutch Programme of Investigations on Storm Surges in the North Sea," by M. J. B. Schijf.

A study of particular interest to the engineer concerned with carrying out maritime works was given by P. Santema in his paper "On the Estimation of the Number of Days with Favourable Meteorological and Oceanographical Conditions for Engineering Operations on the Sea Coasts and in Estuaries."

Ports and Tidal Models.—An important part of the work of the conference was concerned with the study of various hydraulic problems in the design and operation of ports and harbours. The technique and apparatus used for the generation of waves, tides and currents in hydraulic models at the Chatou laboratory were described in a paper by Gridel; a more unusual problem, concerning the fundamental ideas of model design for the study of seiches in harbours, was explained by Biesel. These models are based on the hypothesis that seiche movements are caused by gravity waves coming from the ocean, and their main differences from ordinary tidal models were discussed.

The hydraulic resonators developed by Electricité de France were commented upon in a paper by Valembois and Birard. These structures reflect a range of wave periods incorporating their period of resonance, and a study of their application to harbour problems is given. Another harbour problem was discussed by Valensi in his paper "Windscreens for Harbours," and the construction of fendering systems, and its underlying theory, was described in a paper by P. A. d'Auriac.

Two hydraulic problems studied from Nature are worthy of mention. The lagoon of Aveiro on the Portuguese west coast, has been under observation since the end of the eighteenth century, when the clearing of its choked inlet was seriously studied, for the closing of this inlet, by natural causes, had had a disastrous effect on the prosperity of the surrounding region. Remedial works have been in progress as recently as 1948, and the history of all this work, with its hydraulic background, was given in a paper by C. K. Abecacis. Another study of a similar kind has been undertaken by Laurent, of the condition of Tangier bay, where the spectacular growth of sand beaches had caused the local authorities to fear that the harbour was endangered. The hydraulic phenomena governing conditions in the bay were investigated, and are described in Laurent's paper, and it is concluded that, since the sand "store" in the bay is isolated from further "feeding," the growth of beaches is due to rotation of the sand in the bay, and the harbour entrances are not endangered.

Other papers on these subjects were: "Comparison Between the Turbidity Measured in an Estuary and Turbidity Calculated from Laboratory Tests," by M. A. Wallet; "Experimetnal and Theoretical Study of Port Models," by A. Apte and C. Marcon; "Two Dimensional Seiches in a Basin Subjected to Incident Waves," by B. Le Mehaute, and "The Port of Menton," by M. V. Romanovsky.

A general resumé of the French papers presented at the conference was given by M. A. de Rouville.

British Association

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The Yield Point in Steel

At another session of Section G, on Monday, September 6th, a paper on "The Mechanism of a Simple Drawing Operation" was presented by Professor H. W. Swift. It reviewed investigations into the drawing of a cylindrical shell from a flat circular blank, and described a cup-drawing test for durability.

This paper was followed by one entitled "The Yield Point in Steel," by Mr. G. Murray. In introducing his paper, Mr. Murray said that the marked and sudden yielding which occurred when steel was stressed above its elastic limit had been known for a very long time. To many of those engaged in the usage and study of steel it was regarded as an interesting, but not particularly important, feature and the main purpose it apparently served was to enable a rough measure of the elastic limit of steel to be obtained more easily than with other metals, as the sudden plastic yield was easily apparent using simple testing apparatus. The development of the steel-pressing industry, however, elevated the yield point of steel and its associated effects to a position of major significance and the control of this property became an industrial matter of considerable financial importance.

In the last few years, Mr. Murray claimed, the universities had provided useful working theories to account for the actual cause of yielding on the basis of the keying of lattice dislocations and also to explain the action of remedial measures such as temper rolling, roller levelling, &c., on the basis not only of the dislocation theory, but by the probable influence of internal stresses. There would now appear to be no reason why both the sheet suppliers and sheet users should not make determined efforts to improve methods of yield point suppression. The present method of temper rolling at the sheet suppliers' works was a bad remedy, as it reduced the ductility and led to age-hardening which might degrade a first-class deep-drawing sheet to one which was useful for only simple forming operations. The most likely line of approach would appear to be the modification of roller levellers to make them suitable for treating the dead-soft product after the final annealing operation. If this were done the soft annealed sheet which did not, of course, exhibit strain age-hardening could be stored at the user's works until it was needed and then put through a special roller-levelling operation. Work was actively proceeding on this question and while one could never predict the outcome of scientific investigations, one could hope that practical improvement in sheet processing would emerge.

Cross-Channel Power Cable

On Tuesday, September 7th, the problems involved in providing an underwater power cable connection between England and France were outlined in a paper "The Cross-Channel Power Cable," by Mr. F. J. Lane, Deputy Chief Engineer (Transmission) of the British Electricity Authority. Professor J. Greig presided.

Mr. Lane said the power systems of Western Europe were already interconnected at many points, France having interconnections with seven other systems. The missing link was that between England and France. The French supply system had a maximum demand in 1952–53 of 7,600,000kW and an installed plant capacity of 13,800,000kW, of which 55 per cent was hydro-electric plant. The annual load factor was 61 per cent, compared with our 45 per cent, and there was a much smaller variation between winter and summer maximum demands. If, as an initial step, an interconnector between the two countries with a capacity of 100,000kW were provided, the estimated £4,300,000 capital expenditure would be offset by a reduction in installed generating plant in the two countries, avoiding a total expenditure of £10,000,000 at 1951 price levels. Savings in operating expenses could approach £600,000 a year. Such a connection could be made only by cable.

Mr. Lane dealt with the Channel conditions and said that severe mechanical stresses were involved in lowering a cable from a surface vessel to the sea bed. The depth of water reached a maximum of 216ft, but one large sandbank was covered by only 10ft of water at low tide and there was also the problem of wrecks on the sea bed.

Experience with telegraph cables in the Channel was a guide, but the longest power cables laid in the sea in Britain were the three 33kV cables laid in the Solent, a crossing distance of nearly 3 miles. In 1953, however, a 100kV, d.c. cable was laid between Sweden and the Island of Gotland, a distance of 62 miles.

Dealing with essential cable requirements, Mr. Lane said it would need metal armouring capable of resisting abrasion throughout the whole of its length. Weight and diameter must be a minimum consistent with electrical security and there must be reasonable flexibility to permit laying from the deck of a ship or floating drum. The jointing of manufactured lengths—a regular necessity with land cables—would be unthinkable for a sea cable where the operation might require a ship to remain in one position for forty-eight hours at a time. The cable must be in long lengths to keep the number of joints to a minimum ; if possible, it should be manufactured in one length capable of being laid from one shore to the other without a joint.

Accidents might happen during manufacture and a factory jointing technique must be developed which would keep the diameter and flexibility at the joint similar to those of the cable proper. Protective coverings and materials generally must be chosen for their resistance to chemical attack, electrolytic corrosion and mechanical abrasion. The need for easy laying dictated that a three phase supply circuit should preferably be laid as three single-core cables, with possibly a fourth as emergency spare, and they must be laid not much less than 1000 yards apart to provide clearance for grappling.

After considering the choice of voltage, Mr. Lane said that a 132kV cable circuit of 100,000kW nominal capacity could be conveniently connected into the British 132kV system and the French 90kV and 225kV systems at a 1951 estimated cost of £4,300,000 or £43 per kilowatt. A 400,000kW circuit would require a higher voltage cable and reinforcing connections back to Northfleet and almost to Paris. The estimated 1951 cost was £11,500,000 (£29 per kilowatt). The Joint Committee had proposed experimental programmes dealing with the 132kV project.

After detailed discussions, it had been decided that works developments tests and laboratory and sea trials should proceed on two types of cables—the pre-impregnated gas-filled cable and the gas compression cable. The former used as a filling medium nitrogen gas at a pressure of 200 lb per square inch, but was insulated with paper which had been dried, impregnated and cut before application. The gas compression cable was insulated and impregnated as a normal solid cable but the conductor and surrounding lead sheath were slightly oval. A second and circular lead sheath was then applied and the gap between the sheaths filled with gas under pressure.

Mr. Lane then dealt with both the British and French development programmes. In British trials attention was concentrated on the pre-impregnated gas-filled cable. The selected conductor was 0·5 per square inch stranded copper capable of transmitting nearly 200,000kVA. With a paper thickness of 0·5in the stress at the conductor would be 90kV per centimetre and the stress at the sheath 41kV per centimetre. A lead alloy having 0·4 per cent tin, 0·2 per cent antimony (alloy E) was adopted for reasonable flexibility and resistance to vibration. A clearance of 40–50 mils under the lead sheath would provide extra gas space to accelerate gas charging and assist leak location. The sheath wall thickness of 0·14in ensured that if the cable were laid without internal pressure the sheath would not collapse under the external pressure.

The external jute serving would be damaged during laying, exposing the armour wires to the corroding action of sea-water, so that galvanised steel wire seemed to be a good choice, but with single-core cables 1000 yards apart it was found that the losses in the armour and the lead sheath would be about 170 per cent of the losses in the conductor. As an alternative, an aluminium alloy wire would reduce the sheath and armour losses to about 60 per cent of the conductor loss, and aluminium alloy was used on the experimental cable.

A factory or flexible joint with a diameter no greater than that of the main cable was obtained by butt-brazing the individual strands and lead-burning the joint sleeve to the cable sheath. Special tests were undertaken to investigate external pressure effects such as those to which the cable might be subjected when laid in deep water, electrical and thermal stability of cable and joints, flexibility of factory joints and coiling down of lengths of cable.

The British sea trial aimed at using the G.P.O. cable ship "Alert," floating a length of British cable inshore to a land terminal and testing station, laying two other lengths of cable in deep water and completing two rigid joints on the deck of the ship ; and the exercise was carried out between July 21 and September 9, 1953.

Analysis of the results of the works tests and the sea trials suggested that these main items merited further investigation :—

(1) Coiling down in the ship tanks makes essential careful consideration of the make-up of the cable.

(2) Good adhesion is required between the rubber layer and the reinforcing tapes beneath so that even if the layer is damaged, sea-water penetration is restricted to a small area.

(3) Reinforcing tapes can be buckled and torn when the cable is bent unless they can slide easily over one another and the relative thicknesses are properly selected.

(4) Galvanised steel wire, with an abrasive resistance in water about six times that of aluminium alloy, was to be preferred.

(5) A flexible joint introduces a special

hazard. If the cable is cut near it there is a possibility that slip may occur between the conductors, the paper and the sheath. It will be necessary to anchor the conductor to the sheath in such conditions and to identify the position of a joint for some distance on both sides.

(6) The sea joint must be simplified.

(7) The layout and equipment of any ship used for installation or repairs can have a major effect on the efficiency with which the work is completed.

Mr. Lane discussed methods of laying the cable and said that both the ship method and the method of using steel floating drums were being considered.

He then pointed out that, although his review had assumed that the power transmission would be by alternating current, in fact, for such a cable circuit, alternating current had significant disadvantages. Unfortunately, there were in Britain serious difficulties in proceeding with an application of d.c. high-voltage transmission; little research work had been done on the electrical and thermal characteristics of high-voltage d.c. cable designed for the purpose and still less on the effects of using d.c. on a cable designed for a.c. An Electrical Research Association committee had reached the conclusion that a development period of eight years would be required at an estimated cost of £1,330,000. Probable service applications were few and there were not sufficient possibilities in Britain to encourage such heavy research expenditure.

The experience of the Sweden-Gotland connection encouraged the view that the high-voltage, high-power, d.c. transmission by cable could be made both a practicable and an economic proposition. Mr. Lane said it was reasonable to conclude that a suitable channel cable circuit could be manufactured and installed for a.c. operation. Risk of breakdown due to external causes was difficult to assess, but it was not inappreciable and it would be important to ensure both a good mechanical design and efficient means for rapid fault location and repairs. The early provision of a d.c. circuit seemed improbable, but if a fourth cable were provided as a spare, it would encourage development if it could be made available for experimental high-voltage d.c. transmission as a step towards a later increase of the circuit capacity.

Replying to Mr. T. S. Andrew, in the discussion, the author said he would not think transient instability would necessarily be serious because of the high inertia of the two systems on the two sides. It would take a very unusual fault condition to disturb the tranquillity of the two systems as systems, but it would be essential to provide in association with the channel cable some form of automatic frequency control on the British system. At present frequency control was determined by verbal instruction, but automatic frequency control in relation to load transference would be an essential feature. That kind of equipment was available to some extent on the French system, but not on the British system, and experiments were being conducted as a basis for the wider application of that form of control.

The Chairman asked about the weight of the cable and the radius of curvature within which the cable could be coiled.

Mr. Lane said the total weight of one single core cable would be about 800 to 900 tons. The minimum bending radius was normally 2ft—the minimum radius to which it was safe to bend the cable—but they normally restricted that to a 3ft radius and the sheaths over the prow of the ship were 7ft diameter. On the "Alert" the cables were coiled on a diameter of 12ft to 15ft, for it would be impracticable to use the smaller diameter suggested. The designed limit was 2ft radius and the cable could be bent to a fairly small arc, but it would be difficult and for coiling they had to regard 12ft to 15ft diameter as the minimum.

In reply to another question, Mr. Lane said there were problems in laying the cable at the coastal ends. The British end presented the problem of getting the cable up the cliff, and in any case the cable on land would have to be bigger than the cable in the water. On the French side there was a flat foreshore for 2 miles, much of which was exposed in low-water conditions. It might be necessary to lay a length of cable out from the French shore towards the deep water so that it met the length of cable laid from the British shore. One joint would be necessary at that stage. It would be impossible to get the "Alert" right into shore on the French side. For the majority of that section, however, the cable would be in sand and if there were a fault in the section there might be no alternative but to cut out the section and relay it. The cable would be lost in the sand and could not be grappled. With a rocky foreshore, the cable would be given protection against mechanical damage by anchors, and in the event of such damage they would expect to be able to pick the cable up.

Mr. W. B. Shannon asked how far the seven interconnections between France and other countries had influenced French installed plant capacity. Mr. Lane said he could not answer the question. The ratio between installed plant and load was 2 to 1 for France and about 125 to 100 for this country. That was one of the factors which caused difficulty; on the British side they were concerned mainly with thermal plant and the installation of 100MW connection could avoid the installation of 100MW on the British side, but the same figures could not be used on the French side where the amount of installed plant was so much higher than the total demand. The French had an "over-plus" of plant which could deal with flooded conditions in various regions. The figures given in the paper on this point had been agreed between the two parties as a reasonable assumption.

Mr. T. R. Warren referred to overloading of plant and the load-shedding experienced in this country. With an interconnection with the rest of the Continent, the whole of the Continental frequency would have to be allowed to fall when ours fell. It was difficult to understand that state of affairs being allowed for the import of about 100MW. Mr. Lane agreed that it was a difficult problem and said they assumed that by the time the cable was installed the frequency and power difficulties which we had experienced in the last few years would largely have disappeared. In the event of an emergency, when it became necessary for us to shed load, by reducing voltage and frequency, there would be no option but to separate the two systems. As the first stage of that procedure they intended to design the connection in such a way that a proportion of South-East England could be left hanging on to the channel cable as a means of continuing the importation arrangement while the rest of the country was involved in the frequency and voltage reduction. That could be done by a suitable switching arrangement.

Mr. J. Almond pointed out that France already had seven interconnectors with other countries. He did not see why they were enthusiastic about the eighth. How did they get much out of it? Mr. Lane replied that the arrangement between England and France would be such that any financial savings, such as operating savings, would be equally shared between the two countries. They could arrange that if we imported a certain amount of energy at one part of the day, the French would import an equivalent amount of energy at another part of the day. As for capital expenditure, the saving on plant which was not installed could not appear in the cost account. The savings in operational costs could appear in the direct account and could be adjusted by operating conditions or by a financial arrangement. He thought that a financial arrangement would be much more difficult than an operational arrangement. The French had several international connections on an energy exchange basis.

Mr. E. H. Skinner asked what he described as a political question: if the B.E.A. relied on the 100MW of load from the French, what would happen in war if we had to break the cable? Should we be short of that much plant? Mr. Lane agreed that we should but pointed out that the proportion was insignificant. We were taking about 100,000kW against a background of 15,000,000kW. By removing 100,000kW we should be removing part of the standby margin.

Recruitment to the Engineering Profession

A joint session of the engineering and education sections was held on Tuesday morning, September 7th, for a discussion on "Recruitment to the Engineering Profession." Mr. Ronald Gould, president of the Education Section, was in the chair, and Dr. Willis Jackson opened the discussion. He said that the productive achievements of the engineering industry dominated the entire British economy and it was impossible to visualise a satisfactory future for ourselves except in relation to a healthy, vigorous and creative condition of this industry. Yet, in spite of all that had been done, the recruitment to it was falling short of requirements in both quantity and quality. The situation was causing serious concern. The trained personnel of the engineering industry fell into three main groups—professional engineers, technicians and craftsmen. He explained the difference between the three groups and said that although the primary responsibility for ensuring the continued progress of the industry fell on the professional group, progress depended on the skill, resource and adaptability of the supporting technicians and craftsmen.

In outlining the methods of engineering education, Dr. Jackson said that the courses of technical education and practical training for engineering technicians were perhaps the least satisfactory of those available to engineering personnel, which was because their status was not nearly as well defined nor the importance of their systematic education and training as fully appreciated as in the case of professional engineers and craftsmen. It was desirable that they should reach a standard of general technical education comparable with that of the Ordinary National Certificate, and this should be supplemented by instruction in the principles and practice of the techniques appropriate to their specialised activities. More deliberately organised courses of practical training and of technical study were needed for this important grade of personnel and the Institution of Electrical Engineers had given a lead by seeking, through two recent conferences, clarification of the problems to be solved.

The engineering factory, Dr. Jackson continued, was a highly educative environment. Whether he was a graduate, student or craft apprentice, the young man was brought

into intimate association with men of great and varied skill, of all ages and shades of opinion, and having considerable experience of life in general. Nevertheless, in the absence of organised arrangements for the initiation of the newcomer and for a maintained contact with him by apprentice supervisors throughout his training, the transition from school or university life could be severe. Fortunately, such arrangements were developing rapidly throughout industry, although we must not carry them too far and thereby restrain the development and exercise of individual initiative. For this reason great importance attached to the activities of apprentice associations. Dr. Jackson concluded by raising a number of questions relating to the need to attract more of our most able schoolboys to a professional career in engineering. The accommodation and facilities in the engineering schools of the universities and larger technical colleges had improved considerably since the war and further expansions were in progress. But the number of acceptable applicants for entry to degree courses in engineering was not keeping pace with this expansion; some 300 first-year university places were unfilled during last session. Moreover, he said, a disturbingly large proportion of those accepted—30 per cent in one university college—had failed to pass the first year examination this summer, which, he asserted, was not due to a higher standard of examination and assessment.

This, Dr. Jackson suggested, threw up a number of crucial issues. Could the present number of engineering graduates be increased without a lowering of the standard of degree award or without the addition of a further (intermediate) year of university study for a substantial proportion of the entrants? Was the reintroduction of an intermediate year perhaps the only effective early solution to the problem of the shortage of science teachers in the schools? In any case, was not such a transitional year essential if we were to bring into the university engineering, and indeed science, schools a proportion of the boys who, because of circumstances rather than over-riding inclination, followed the arts side of the sixth form work? Furthermore, would the boys who were failing in the first year course, possibly through difficulties of adjustment to the changed educational conditions rather than lack of adequate ability, have had their chance of success improved by spending a year in industry, or alternatively by completing their military service, before entering the university? Or, to go a step further, were we contriving to draw into the university engineering schools boys who would be better served by entering industry as student apprentices and following a sandwich course? Finally, could we hope to achieve what was needed without establishing more effective means of informing schoolboys and their parents—and schoolmasters—of the nature, attractions and prospects of engineering as a career, and of ensuring a wider appreciation of the fact that the systematic study of engineering afforded an education which was at least as valuable, as searching and as character-building as one in either pure science or the humanities?

Conclusion

Three other papers were presented to Section G on September 7th. They were "The Status of the Engineer in Management," by Mr. Bosworth Monck; "The Printing and Making of Books," by Mr. Charles Batey, and "The Photographic Composition of Reading Matter by Machinery," by Mr. George Westover.

Hydraulic Power Shovel

A HYDRAULICALLY operated, pneumatic-tyred power shovel which was recently demonstrated to us is being manufactured by Ahlmann Carlshuette K.G., of Rendsburg, Germany. The machine, called the Ahlmann swing shovel, is being made in three sizes, and the following details apply to the "AII" model, which will lift 1 ton at any radius of the boom.

It is powered by a Deutz "F2L514" two-cylinder, four-stroke, air-cooled diesel engine, developing 30 h.p. at 1600 r.p.m. (continuous rating). A single-plate dry clutch takes the drive through a four-speed crash gearbox, independent reversing gearbox and differential to the two front wheels. All gears are thus available both in forward and in reverse direction; maximum speed in top gear is 10 m.p.h., and 1¾ m.p.h. in first.

Steering is to the rear wheels, the rear axle being centrally pivoted to accommodate the machine to uneven terrain. The large tractor-tyred front wheels are equipped with foot-operated servo brakes, and an independent hand brake is fitted to the transmission.

A hydraulic pump mounted on an extension of the crankshaft supplies power for slewing and lifting the boom and for tilting the bucket. The mechanism, clearly shown in our illustration, consists of a slewing table, supported on a large diameter double ball race, on which is hinged the boom, which in turn carries the bucket. Raising and lowering of the boom is accomplished by a triple telescopic hydraulic cylinder, and the bucket is tilted through a linkage by another cylinder. The arrangement allows the boom to be swung through 90 deg. to either side of the central position. Maximum depth of excavation is 15in below road level, and maximum discharge height is 11ft 2in. Controls include steering wheel, hand and footbrake, clutch and accelerator pedal, electric starter button and horn. To prevent one driving wheel from slipping, with resultant loss of crowding power, the differential may be locked by a hand lever. The three hydraulic control levers are arranged in a bank to the right of the driver.

The machine can readily be converted to operate as a crane, grapple, or bulldozer by mounting suitable other fittings in place of the bucket, and in order to allow the maximum load to be handled irrespective of density, buckets of different capacities up to 1 cubic yard are available. At the demonstration the machine showed itself capable of light excavation work and of shovelling sand and rock. A lorry was loaded with 6 tons 4 cwt of gravel in under four minutes.

Abelson and Co. (Engineers), Ltd., of Sheldon, Birmingham, 26, is the sole agent in the United Kingdom for all three models.

Power shovel with boom in lowered position. The driver's right hand is on one of the three levers controlling the bucket movement

Document Copying Equipment

A PRINTING equipment particularly intended for document copying purposes which is now being made by Kodak, Ltd., Wealdstone, Harrow, Middlesex, is designed to copy large documents such as maps, drawings, &c., up to 30in by 40in. It can also be used for smaller documents and up to twelve quarto sheets can be copied simultaneously. The equipment consists of a strong wooden cabinet covered with a hard wearing grey plastic material and edged with light alloy strip. Its printing bed comprises a ¼in sheet of plate glass which is matt on its underside. A counterbalanced wooden frame fitted with a flexible beaded rubber blanket is hinged to the top of the cabinet.

When using the printer the document and a sheet of copying paper are placed on the printing glass and the frame with its blanket are swung down and locked in position. A small motor-driven vacuum pump in the base of the printer exhausts the air from beneath the blanket, so that document and document paper are pressed firmly into contact against the printing glass. With this method of holding, the document to be copied can be either in the form of a flat sheet or a bound volume.

The intensity of the printing light can be adjusted to suit the speed of the printing paper. For the maker's "Autopositive" paper a high level of illumination is provided by the use of a combination of six 300W, eight 100W, four 60W and four 40W pearl tungsten lamps. For reflex and contact printing with normal document-copying papers, a lower level of lighting is available and this employs four 60W and four 40W pearl tungsten lamps. For inspection and positioning, two red-sprayed 25W lamps are used. Either combination of lamps can be brought into action by a switch.

A retractable yellow screen which is fitted beneath the printing glass to improve clarity and contrast in the print, works on the roller-blind principle and is operated by a handle. An electric timer enables any exposure up to sixty seconds to be pre-set. When the document has been placed in position, with the wooden frame and rubber blanket clamped down, the setting of the pointer of the timer for the required exposure automatically starts the vacuum pump. When the exposure button is pressed the printing lights are switched on and, upon completion of the exposure, the vacuum pump and printing lights are automatically switched off. An exposure can be repeated any number of times simply by turning the timer pointer to a stop and pressing the exposure button. This automatic exposure is designed for use on a.c. circuits, 200/250V only; a hand-operated switch for use on d.c. circuits can be supplied to order.

Two-High/Four-High Experimental Rolling Mill

(*By Our American Editor*)

The increasing demand for such relatively new engineering materials as titanium, zirconium, molybdenum, tungsten and tantalum in the form of bar, rod and strip has led to much current American research and development work in the fields of hot and cold rolling. An interesting two-high/four-high combination rolling mill has been developed in America to provide a versatile laboratory facility capable of reducing these materials from the ingot breaking down to the strip finishing stage.

THE corrosion resistance, heat resistance and favourable strength-to-weight ratio applicable to some or all of the above metals has created much interest recently in their development as engineering materials. The primary production of most of these metals in ingot form is still a difficult process, involving such special techniques as arc melting, induction melting and compacting and sintering by powder metallurgical methods. Fortunately, the subsequent hot and cold working procedures are generally more conventional, although the workability of these metals ranges all the way from the excellent ductility of tantalum, to the crack susceptibility of molybdenum and the extreme brittleness of tungsten at room temperature. Expressed numerically in terms of mechanical properties, the range of cold working characteristics of these three powder metallurgical products may be summarised as follows :—

Material	Thickness, in	Tensile strength, lb per sq. in	Rockwell hardness
Cold-worked tantalum strip	0·010	110,000	B-63
Cold-worked molybdenum strip	0·010	175,000	C-27
Cold-worked tungsten strip	0·010	300,000	C-47

These figures readily show the wide range of loading imposed upon the rolling mill equipment that is required to work these materials from the initial ingot breaking down to the finishing of strip at ultra-thin gauges in the neighbourhood of 0·001in. The resulting equipment problem can be solved easily in the case of high-production plants, where the quantities processed justify the installation of a series of rolling mills to take the product through the several stages of hot and cold reduction. However, the many research laboratories and metallurgical pilot plants which are to-day faced with the processing of metals and alloys in experimental quantities clearly cannot afford the range of individual mills normally required to take an ingot of, say, 2in thickness down to 50 S.W.G. strip. Furthermore, it has been found time and again that it is impractical to perform experimental rolling work on production mills. Such test runs usually interfere with works production schedules and may cause much friction between a company's mill personnel and research staff. Thus, it was realised that there exists a need for a high-precision mill capable of performing the widest possible range of bar, rod and strip reduction and designed in the most compact manner to fit into the often restricted space of metallurgical laboratories. The two-high/four-high combination rolling mill has been developed by the Stanat Manufacturing Company, of Long Island City, New York, to fill this need.

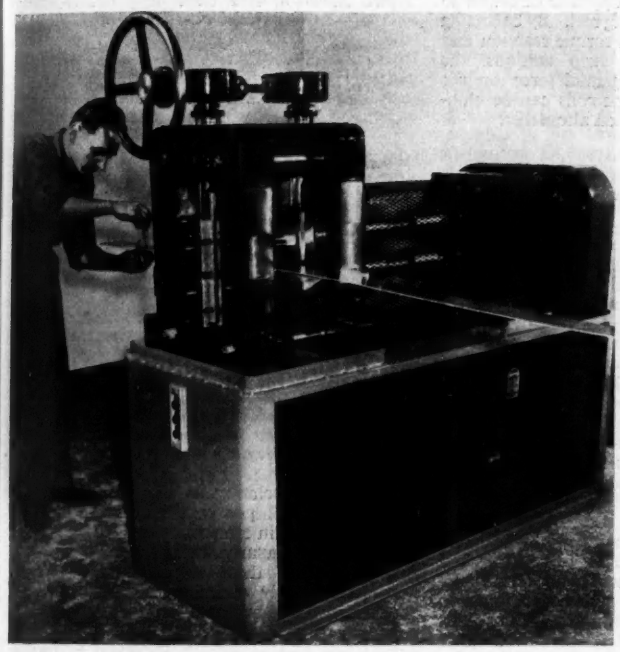


Fig. 1—Cold reduction of bar using two-high arrangement of rolling mill

Two-High Operation

When working as a conventional two-high unit (Fig. 1), the mill has a relatively large work roll diameter which is valuable for the breaking down of ingots and billets, and in the skin-pass rolling of annealed strip, when it is usually desired to take a reduction of only about 1½ per cent. Similarly, such rolls are employed with advantage when reducing strip with little or no lubricant to obtain a bright and highly burnished surface finish. This lustre effect is directly due to the fact that the larger the work roll diameter the greater the amount of slipping between the roll surface and the material.

Finally, the two-high mill configuration is still largely preferred for the rolling of mirror-finish strip using extremely hard and close-grained rolls super-finished to an r.m.s. value of 1 micro-inch by means of diamond compound lapping. In such ultra-precision work it is not desirable to have the continuous line contact between the work and back-up rolls, and wiping of the work rolls with the aid of felt pads is more readily effected in the two-high design. Furthermore, a larger diameter work roll, with its greater circumference, is subject to relatively less wear and thus offers longer satisfactory performance between regrinding.

Four-High Operation

Almost every engineer or metallurgist using two-high strip mill equipment sooner or later becomes stymied by the inability of his completely screwed-down mill to produce any further gauge reduction. In such a case, even a further intermediate anneal often is of little help, and the only solution is to continue processing the strip on four-high or cluster mill equipment having considerably smaller work rolls backed up by large supporting rolls. The concept of a two-high/four-high combination mill was developed particularly to overcome this drawback. Depending on the application of such a machine, it may be considered primarily as a two-high mill designed for the rolls to be raised sufficiently to allow the insertion between them of a set of two small diameter work rolls. Alternatively, it may be regarded as a four-high mill with driven back-up rolls designed to facilitate rapid change-over to a conventional two-high configuration by withdrawal of the two work rolls (Fig. 2). In the latter case, the original back-up rolls thus become the work rolls in the two-high arrangement.

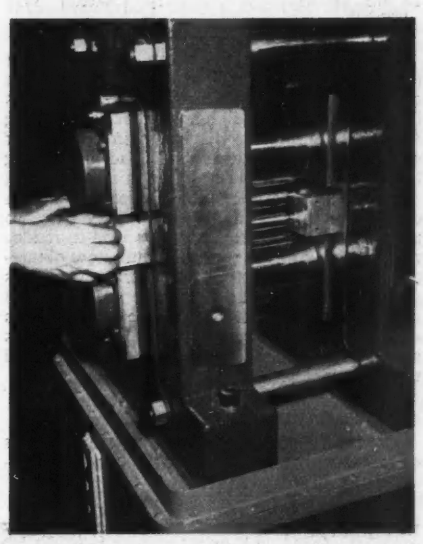


Fig. 2—Removal of work roll assembly to convert mill from four-high to two-high arrangement

All forms of backed-up rolling mills have for their object the largest practical reduction in the diameter of the work rolls. Extensive research into the cold rolling of strip has established that—for a given material, reduction and width—the roll load, rolling torque, rolling horsepower and lateral spread of the strip decreases with the diameter of the work rolls. Consequently, for a mill of given roll load capacity and horsepower, greater reductions may be taken with work rolls of smaller diameter. The reduction in lateral spread with reduction in work roll diameter also has considerable practical advantage in the rolling of the harder metals and alloys as it reduces the tendency of the strip edges to tear or crack. The "stiffness" of the backed-up four-high mill and the ease with which its small work rolls can be cambered have made possible the production of extremely accurate strip having practically no gauge variation across its width. Finally, a smaller work roll allows thinner strip finishing gauges to be obtained even in highly work-hardened materials since the length of the flattened arc of contact between the work rolls and material—and, hence, the roll load and rolling torque—decreases with decrease in work roll diameter.

An interesting illustration of the latter phenomenon may be obtained by comparing the roll load and the rolling torque involved in reducing the American Ti-75A grade of commercially pure titanium strip from 0·015in to 0·012in in a width of 6in using (*a*) the 8in by 8in two-high configuration, and (*b*) the 2in and 8in by 8in four-high configuration of the mill. The calculations required were performed using the method of Bland and Ford,* which allows for the effect of roll flattening being based in this respect on Hitchcock's formula. The calculations assumed (1) rolling without tensions ; (2) a $1{\cdot}15 \times 84{,}000$ lb per square inch constrained mean yield stress of the material being rolled

* D. R. Bland and H. Ford, *Proc. I.Mech.E.*, "Applied Mechanics," Vol. 159 (1948), pages 144–163.

following an intermediate anneal; (3) rolls made of steel for which Young's Modulus of Elasticity = 30,000,000 lb per square inch and Poisson's Ratio = 0·3, and (4) a coefficient of friction between rolls and strip of 0·10.

Mill arrangement	Radius of undeformed work roll	Radius of deformed work roll	Roll load	Rolling torque per roll
	in	in	lb	lb-in
8in × 8in two-high	4	10	202,000	65,000
2in and 8in × 8in four-high	1	1½	49,000	975

It is evident from the above tabulation that the great reduction in roll load and rolling torque made possible by the four-high arrangement is largely due to the small diameter work roll being much less subject to flattening in the arc of contact. The reduction in roll load and rolling torque have been made even greater by employing tungsten carbide work rolls. Cemented tungsten carbides have a modulus of elasticity twice to three times that of steel and thus tend to reduce roll flattening to the very minimum now obtainable. The back-up driven four-high mill is particularly well suited for the use of solid tungsten carbide work rolls—the roll shape is simple, the weight relatively small and there is no requirement for torsional loads to be applied through wobblers.

Mill Drive

Depending on the required range and speeds of reduction to be performed, the two-high/four-high combination rolling mill may be powered by a constant speed a.c. motor, a four-speed gearshift a.c. motor, an eddy-current clutch variable speed a.c. drive, or a Ward-Leonard variable speed d.c. drive. Similarly, the method of providing front and back strip tension may be varied in accordance with maximum strip pull requirements and coil build-up ratios. In the simplest arrangement on a non-reversing mill, back tension is applied by means of a friction brake on the pay-off reel, and variable front tension is obtained by driving the coiling reel from the main mill motor through an adjustable slipping clutch. On the other hand, a reversing mill may have a variable speed constant tension regenerative drive with d.c. equipment on the mill and both reels. The improved reductions and strip flatness obtainable with the application of front and back tensions is of particular importance in cold-working thin, hard metals, and in the processing of these materials tensions equivalent to one-third to one-half of the yield stress of the strip are frrquently employed.

The mill motor is generally mounted in the base of the machine and drives the pinion stand through double-helical reduction gearing. The mill pinions have double-helical teeth and drive the two large diameter rolls through spindles equipped with heavy-duty universal joints. The lower spindle can be arranged to incorporate a torque-meter allowing a continuous record of rolling torque to be obtained during operation of the mill. Similarly, provision has been made for load cells to be placed between the upper chocks and the roll adjusting screws, so that the respective roll loads can be indicated continuously.

In such an "all-purpose" mill there is much to be gained from driving the back-up rolls rather than the work rolls. While originally there was objection to this method on the grounds that slipping would occur between the work rolls and the back-up rolls, the extensive and successful service of back-up driven four-high mills in both the ferrous and non-ferrous metal industries in the United States has proven the soundness of this design. The back-up drive eliminates one of the most serious disadvantages of the conventional work-roll-driven four-high mill: the limitation in torque that can be transmitted by the relatively small roll necks and spindles without exceeding their permissible torsional shear stress. This limitation is particularly serious in the case of carbide rolls which have a comparatively low torsional strength. Another advantage of the back-up drive is its ability to overcome the lateral bowing out of the small work rolls when heavy reductions with high front tension are being taken. Driving the back-up rolls causes a torque reaction on the work rolls which tends to bend them toward the entry side of the mill, i.e. in the opposite direction to the force exerted by the coiling reel. By balancing this torque reaction and the strip tensions, the tangential force on the work rolls can be eliminated altogether.

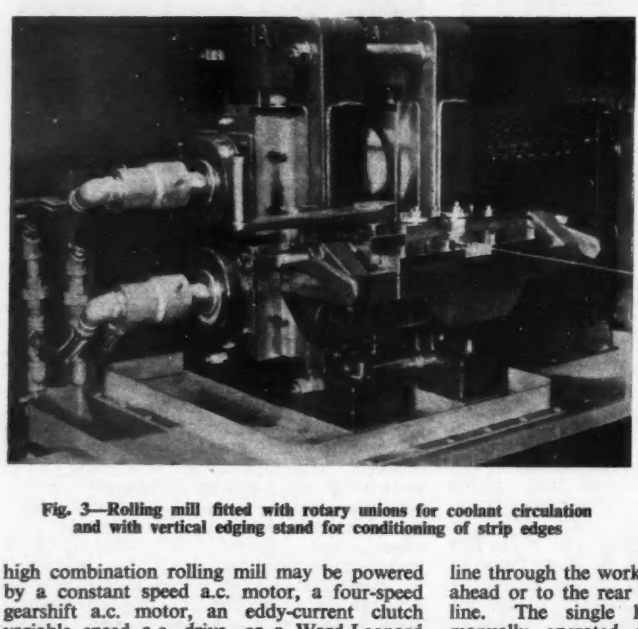


Fig. 3—Rolling mill fitted with rotary unions for coolant circulation and with vertical edging stand for conditioning of strip edges

Mill Stand

The housings of the two-high/four-high combination rolling mill are high-strength iron or steel castings mounted on a unit base of fabricated steel plate construction. The housing posts have been designed with exceptionally large cross-sectional areas to obtain an extremely rigid mill capable of handling severe roll loads without undue deflection. Depending on the size of the mill, either a mechanical or a hydraulic roll lift method is employed. By the use of exchangeable shim plates, the vertical centre line through the work rolls can be moved either ahead or to the rear of the back-up roll centre line. The single handwheel screwdown is manually operated and is equipped with a simple clutch device to allow roll parallelism correction. The opening of the rolls is indicated in 0·0001in by micrometer dials directly connected to the screwdown mechanism. Anti-friction roll neck bearings are used on the back-up and work rolls, with ample capacity being available for both radial loads and end thrust. In the four-high arrangement of the mill, the back-up drive allows the diameter of the work rolls to be changed without changing the rolling speeds. As there is no need for universal spindles to be disconnected, the small work rolls may be changed quickly and easily.

The standard rolls for the mill are made of close-grain alloy steel, hardened to Rockwell C-64 minimum, and ground and lapped to a mirror finish. When used as a conventional two-high unit, the mill may be equipped also with grooved rolls for the reduction of round, square and other shapes. Furthermore, both flat and grooved rolls are available in either chilled iron or in a special "Hotform" alloy steel which allows hot rolling to be performed over a roll temperature range up to 1000 deg. Fah. For heat dispersion purposes in hot rolling the mill may be equipped with a self-contained bearing lubricant circulating, cooling and filtering system. Moreover, to facilitate internal cooling, water may be circulated through rolls having a central cavity, fitted with rotary unions and flexible hose lines (Fig. 3).

In rolling the heavier gauges of strip, it is frequently necessary to edge condition the material. This operation may be combined with the actual reduction in the mill by mounting a vertical edging stand at the entry or exit side of the machine (Fig. 3). The stand has hardened alloy steel non-driven rolls equipped with a number of grooves to match the required edge shape and is furnished with a cam-operated quick-acting roll opening device.

Mill Performance

In an effort to establish the performance characteristics of the two-high/four-high combination mill, extensive rolling tests were conducted recently on a 1½in and 5in by 8in mill equipped with a 10 h.p. four-speed gearshift drive. The materials which were reduced successfully in the course of these tests included carbon steels, stainless steels, silicon steels, titanium alloys, nickel-iron magnetic materials, Hastelloys, Inconel-X and other "superalloys." The following table shows the results of a representative pass sequence in the cold reduction of Inconel-X strip on this mill :—

Typical Results in Cold Reduction of Inconel-X Strip on Two-High/Four-High Mill

Material	Inconel-X
Initial size	0·099in × 3in
Initial hardness	Rockwell B-89
Initial tensile strength	125,000 lb per sq. in
Rolling speed	35ft per min

A: Two-High Operation

Pass No.	Thickness	Reduction, per cent
1	0·074	25
2	0·059	20
3	0·049	17
4	0·041	16
5	0·035	15
6	0·030	14

B: Four-High Operation

7	0·026	14
8	0·022	15
9	0·019	14
10	0·0165	13
11	0·0145	12
12	0·013	11
13	0·0115	11
14	0·0105	10
15	0·0095	9
16	0·0088	8
17	0·008	8

Thus, the machine was able to effect a total reduction of 92 per cent in seventeen passes without any intermediate anneals. Similar results are regularly being obtained by the many users of these laboratory rolling mills and have greatly contributed to their growing popularity as a versatile tool in metallurgical research.

Tennessee Valley Authority

The rated generating capacity of the T.V.A. power grid recently passed the 6000MW mark when the third 135MW turbo-generator at the Kingston steam power station, near Kingston, Tennessee, went into commercial operation. The present capacity of 6,075,685kW consists of 3,455,935kW of hydro-electric power and 2,619,750kW of steam-electric power. The units which are now under construction will bring the total rated capacity of the system to nearly 10,000MW by 1956. When T.V.A. began operations in 1933 its power producing "system" consisted of the Wilson Dam with 184MW installed, and the Wilson steam power station of 64MW. By September, 1939, the T.V.A. grid capacity had risen to 749MW. It was 1065MW when the attack came on Pearl Harbour, 1677MW when Italy surrendered in September, 1943, 2490MW when Germany surrendered, and 2507MW when the last war ended with the capitulation of Japan.

Industrial and Labour Notes

Overseas Trade

The trade accounts for August, which have now been published by the Board of Trade, give the final figure of United Kingdom exports for the month as £205,600,000. The effect of annual holidays and the fact that there were only twenty-five working days in August are shown in this figure, which was £41,000,000 lower than that returned for July.

If the two months, July and August, are considered together, however, the average value of exports was £226,000,000, or 1 per cent higher than the monthly average in the first two quarters of this year. The Board of Trade says that the gains in overseas markets which have been made during the past year have, on the whole, been maintained and extended in some sectors, although North America remains an important exception. So far this year the total value of exports of United Kingdom goods has been over £100,000,000 more than in the comparable period of 1953. Imports in August were valued at £266,800,000, and over the first eight months of this year the trade deficit averaged £44,900,000 a month, compared with £58,900,000 a month in the corresponding period of last year. There was some recovery of export prices in August after the slight fall in the preceding month, but there was no change in import prices. Consequently the terms of trade reverted to the level at which they have been maintained, with minor fluctuations, for over a year. In July and August the volume of imports was 2 per cent less than the monthly rate in the first half of this year, while the volume of exports was practically unchanged.

About the commodity pattern of exports, the Board of Trade says that the engineering products divisions, which had maintained a high rate of export in the first seven months of this year, did less well in August. A decline at this time of the year, however, is not unusual because of seasonal factors in supply and demand for such items as road vehicles and tractors. For the two months, July and August, exports in these categories amounted to £84,700,000 a month, which was only 1 per cent below the monthly average in the second quarter. The principal decline was in machinery, other than electrical, where exports averaged £33,900,000 a month in July and August, which was about 4 per cent less than in the preceding three months. The reduction was spread over many of the main classes of machinery. Exports of railway vehicles and of road vehicles were also lower by about £500,000 a month each in July and August than in the second quarter. Exports of road vehicles in particular are subject to seasonal fluctuations and the slight decline on average for the two months is therefore not considered to be abnormal. Exports of aircraft, however, were somewhat higher on average in July and August than in the second quarter. In the electrical machinery division, exports were little changed at about £14,000,000 a month in July and August.

Railway Wages

On Friday last representatives of the three railway unions met the British Transport Commission for further discussion of the Commission's latest wages proposals. The proposals put forward by the Commission were : that for conciliation staff other than footplate grades agreement should be reached on the scale for the highest-rated wages grade, and that an appropriate rate should be agreed for the top-rated engine driver ; that the minimum rate of £6 5s. a week, rising to £6 7s. after a year's service, provisionally agreed for the conciliation staff, should apply ; that immediate negotiations should take place to resolve the position of the remaining wages grades between the highest and lowest paid staffs, and that there should be a thorough review of the salaries structure including the basis of classification.

A joint statement which was issued after the meeting said that two of the unions—the National Union of Railwaymen and the Transport Salaried Staffs Association—agreed to these proposals. The representatives of the Associated Society of Locomotive Engineers and Firemen, however, intimated that their instruction to pursue their union's claim through the agreed negotiating machinery still stood, though they would pass on to their executive a report of the Commission's proposals. On Tuesday the union executive considered the proposals but decided that it could not accept them as a basis for resumed negotiations with the Commission.

Coal Statistics

The National Coal Board has issued this week a statistical statement of the costs of production, proceeds and profit or loss of collieries for the second quarter of 1954. The statement records that during the quarter the saleable coal from the Board's mines amounted to 53,074,351 tons. Of that amount, 49,504,846 tons were disposed of commercially, 2,330,339 tons were required for mine consumption, and 1,239,166 tons represented miners' coal.

The total proceeds from the sale of coal during the quarter amounted to £167,842,471 and the total costs to £163,192,376, so that, before charging interest, there was a profit of £4,650,095. To that, the Board has added £900,000 as the estimated profit on opencast working and £200,000 as the estimated profits of its ancillary undertakings, making a total of £5,750,095. That sum was reduced by £1,365,000 representing interest (£145,000), loss on imported coal (£420,000), and provision for taxation (£800,000), leaving an estimated profit for the quarter of £4,385,095. As the estimated interest payable to the Minister of Fuel and Power is shown as £4,650,000, the statement records a deficit for the quarter of £264,905.

Dealing with production costs, the statement says that wages, including holiday pay and allowances in kind, required £101,510,601 ; roof supports, general stores and repairs required £27,905,267 ; coal and power consumed accounted for £8,545,240, and that other costs, including depreciation, amounted to £25,231,268. The average weekly cash earnings during the quarter were £13 9s. 3d. for face workers, £12 6s. 6d. for all underground workers, and £9 8s. 8d. for surface workers.

Taxation and Industry

In a paper entitled " Effects of Taxation on Business Finance," which was presented by Mr. J. H. Lord, last Monday, at the annual Taxation Conference at Harrogate, it was urged that this country should be put on a level with other exporting nations in the taxation of plant and expenditure on research. Mr. Lord said that it was now common practice in the U.S.A. to recognise the continuous progress and development of machinery, largely governed as it was by technical changes flowing from laboratories, and to attribute much shorter working lives to new fixed assets. Americans, and others, too, were facing up to that development when installing new processes and plant or introducing new products, so that even a ten-year life was, if anything, long to their way of thinking.

There was evidence, Mr. Lord continued, of other countries' taxation authorities equally recognising the same trend in depreciation rates. They were not rigidly basing their acceptance of plant " life " on out-of-date records, and penalising industry which was the best judge of the reasonable expectation of life of fixed assets. In India, Mr. Lord stated, double rates were now allowed for the first five years' life ; in Germany 70 per cent of the original cost could be written off in the first four years, and in Canada a ten-year basis was available. But in this country, Mr. Lord went on to say, because of greater rigidity, and now the withdrawal of the initial allowance, little or no choice was available, no matter what greater financial depreciation directors felt it right to adopt. The comparative life in Britain to write off a similar asset was not less than fourteen years, and in most cases probably longer.

That, Mr. Lord said, represented a considerable handicap to British exporting industry, a handicap which would become much more apparent in a few years' time since the major competing countries for world exports would inevitably be able more readily to finance more modern equipment. He suggested that the present rigid system in this country should be made much more flexible, and that depreciation rates, especially for the first five years, should be considerably increased. In industry, Mr. Lord observed, that would be needed within the next year or two, and not in fifteen or more years' time as appeared to be the thought behind Government policy up to date to meet the re-equipment problem.

Derating

In an address to the southern region of the Federation of British Industries, at Reading, on Tuesday last, Sir Harry Pilkington commented that some of our manpower resources were still used wastefully, and because there were still so many people employed by the Government, taxation remained far too high. The time for the F.B.I. to decide on the attack to reduce national taxation this year, Sir Harry said, had not yet arrived. It was not only a national affair, however, for it was also a matter of local government and local taxation.

Local authorities, Sir Harry suggested, were at last finding that the enormous expense they carried was more than they could raise, and the gap was more than the central Government was willing to bridge. Local authorities were looking for a way to increase their revenue instead of cutting their costs. The way that seemed to them to be at hand, Sir Harry continued, was to abolish derating, a " life-saving " concession that had been made to industry twenty-five years ago at a time when the export trade was threatened and when our industrial future seemed to be in jeopardy. Derating was a reasoned, calculated stimulus, and the fact that industry, at the moment, was prosperous was no reason for reimposing on it a permanent burden running into many tens of millions of pounds a year. For one thing, Sir Harry added, industry would not always be prosperous, and even now its prosperity was barely sufficient to provide the funds needed for the future for more mechanisation and expansion. To take away now from industry the relief of derating, Sir Harry claimed, would indeed be a shock to confidence and would undo the good that had come from the wise encouragement the Chancellor of the Exchequer had given to investment in plant and machinery by the new investment allowances.

Productivity in the Building Industry

The British Productivity Council has published a review of productivity in the building industry, an industry which, it is stated, " is undergoing a major revolution in production techniques and is now operating at new post-war records." The object of the review is to emphasise the urgency of applying, throughout the industry, pre-planning and standardisation as well as team work.

The review says that the national organisations of the various sections of the industry and many individual firms are fully aware of their responsibilities. There is, however, a general feeling that in some quarters too little appreciation is shown of the necessity for abandoning the traditional methods of centuries and for introducing new ideas and new materials. It is claimed, for example, that there are many who realise that the building industry could benefit from the wider application of work study, not only as a way of increasing the output of the operative but of improving methods and the organisation of production. Builders who have applied incentive schemes based on measured performance have discovered, the report says, that one particular advantage is that to obviate idle time the operative will demand efficient organisation of the work by management.

Notes and Memoranda

Rail and Road

BIRMINGHAM-LONDON TRAFFIC COSTS.—Firms throughout the country have been asked by the British Road Federation to help in estimating the costs of moving goods between London and Birmingham on the present routes. The Federation is for the first time inviting the direct co-operation of road users to produce a detailed economic survey of a specific link between important industrial areas. With the co-operation of the Road Research Laboratory, the Federation has compiled a questionnaire covering journey times and fuel consumption. Calculations have shown that motorways can save as much as 40 per cent in fuel consumption, 50 per cent of running time, and 30 per cent of tyre wear and general operating costs, and the Federation will compare the cost figures it obtains with estimated costs on a London/Birmingham motorway. Commercial vehicles concerned in the investigation use two routes—A41 between London and Birmingham, and A5 from London to Weedon, branching off on A45 into Birmingham.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—At the annual general meeting of the Institution of Locomotive Engineers, held in London on Wednesday evening, the following awards were presented by Mr. R. C. Bond, the retiring president :—Frederick Harvey Trevithick Award, to Mr. E. S. Cox for his paper " Experiences with British Railways Standard Locomotives " ; Institution of Locomotive Engineers Award, to Mr. S. O. Ell, for his paper " Developments in Locomotive Testing " ; Charles S. Lake Award, to Mr. A. W. Manser, for his paper " The Wearing Parts of Electric Rolling Stock—a Review of the Experience on the London Transport System " ; Alfred Rosling Bennett Award, to Dr. H. I. Andrews, for his paper " The Measurement of Train Resistance " ; and Stewart Dyer Awards, to Mr. C. H. De Sousa, for his paper " Design of Indian Railways Passenger Coaching Stock for Greater Comfort " ; and to Mr. J. N. Compton, for his paper " Production of Steel Fireboxes." In addition to these awards, the council has made a special award to Professor W. A Tuplin, for his paper " Some Questions About the Steam Locomotive."

MAINTENANCE OF ROAD GOODS VEHICLES.—The annual reports of the licensing authorities for goods vehicles for the year ended September 30, 1953, show a fairly general improvement in the standard of vehicle maintenance. The summary of the annual reports, which has been published by H.M. Stationery Office, adds, however, that there is still room for improvement among vehicles in the light classes, particularly small vehicles used on retail deliveries. It is thought that the principal reasons for this are the continuous use of the vehicles, inadequate servicing, the rough-and-ready manner in which the vehicles are driven, and the high cost of repairs. At the end of 1953, goods vehicles in Great Britain authorised by carriers' licences issued under the Road and Rail Traffic Act, 1933, numbered 1,034,037, of which 104,093 were operated under public " A " and contract " A " carriers' licences, 63,622 under limited " B " carriers' licences, and 866,322 under private " C " carriers' licences. Included in the total of " A " and " C " licensed vehicles there were 52,233 vehicles owned by the British Transport Commission, licences for which were required under the provisions of the Transport Act, 1953. The disposal of the nationalised road haulage undertaking of the Commission to private ownership and the issue of special " A " licences to purchasers of transport units had not advanced sufficiently, it is stated, to be reflected in the reports.

Air and Water

WATER POLLUTION RESEARCH LABORATORY.—The Water Pollution Research Laboratory will move on October 1st from its temporary premises in Watford, Birmingham and elsewhere to a new permanent building in Elder Way, Stevenage, Herts. Although most of the staff are moving in during October, it is likely to be some time before all the equipment has been installed and work is proceeding smoothly. It is not likely that an official opening will be made before the spring. The new premises include a three-storey block, containing administrative offices, an information section and microbiological, chemical and physical laboratories. There are also four pilot-scale laboratories and facilities for building larger experimental plant in the open. Special facilities have been provided for experimental work on the treatment of sewage and industrial wastes. For example, up to 50,000 gallons of domestic sewage per day can be pumped for experimental purposes from a sewer crossing the site. There is a radio-chemical section, which will be concerned at first particularly with problems of disposing of radioactive liquids. Two of the pilot laboratories are designed for experiments on the effect of pollution on fish ; this work is carried out in collaboration with a team of biologists of the Ministry of Agriculture and Fisheries.

RECONSTRUCTION AT PARKESTON QUAY, HARWICH.—Two years ago the Eastern Region of British Railways began reconstruction work on the old eastern section of Parkeston Quay. This portion of the quay was the first to be constructed, in 1881, and is 1800ft long and 100ft wide. It is on this portion that the Harwich-Hook of Holland ships, and those of the Danish service, normally berth. The old form of construction consisted of timber decking and bearers carried on steel and wrought iron joists spanning between the piles. At the water front the structure is carried on a double row of concrete cylinders surmounted by a heavy concrete wall. Behind this are rows of cast iron screw piles with wrought iron bracing and the rear 40ft is on timber piles. The concrete cylinders and cast iron piles are in satisfactory condition, it is stated, and the timber piles are generally sound, but a small number at the seaward end are being replaced by steel box piles. The timber deck and wrought iron joists are being removed and replaced by a new reinforced concrete deck for the front 60ft width and the rear 40ft is, wherever possible, being repaired in its present form from recovered serviceable timber. In the new construction sleepered track will be used on a ballast bed and finished to rail level with a macadam surface throughout. The dolphin at the east end has been replaced with a new one consisting of steel box piles and a concrete cap. A new fender system has been provided consisting of hanging timber fenders mounted through rubber springs on to reinforced concrete buttresses and walings. This system has been developed to accommodate the ships up to 5000 tons which use the quay. The whole of the work has been done in sections so that the normal business of the port could be carried on with the least possible inconvenience. A new car examination shed has also been completed and a new garage 125ft long and 40ft wide erected.

Miscellanea

FUEL EFFICIENCY ADVISORY COMMITTEE.—The Minister of Fuel and Power has reconstituted his fuel efficiency advisory committee by the appointment of three additional members. They are Dr. G. E. Foxwell, Mr. B. E. A. Vigers, and Dr. W. A. Macfarlane. Captain (E) W. Gregson is the chairman of the committee.

EAST-WEST TRADE.—A booklet entitled " East-West Trade " has just been published by The Credit Insurance Association, Ltd., Staple House, Stone House Court, London, E.C.3. It surveys " east-west " trade matters, and is intended as a guide to British firms anxious to sell their goods to countries behind the iron curtain.

EUROPEAN MACHINE TOOL EXHIBITION.—In the article on the European Machine Tool Exhibition in our issue of September 10th it was inadvertently stated that the Heidenreich and Harbek gear cutting machines were handled in this country by the Sykes Machine Tool Company, Ltd. These machines are distributed by Lerche Machine Tools, Ltd.

INSTITUTE OF METALS.—The council of the Institute of Metals has elected Mr. H. S. Tasker a Fellow, in recognition of his distinguished services to the Institute. Mr. Tasker, who was president of the Institute of Metals in 1950–51, is the chairman of British Titan Products, Ltd. He was elected to membership of the Institute of Metals in 1933.

INSTRUMENTATION AND PROCESS CONTROL.—A course of lectures on " Instrumentation and Automatic Process Control " is to be given at the Northampton Polytechnic, St. John Street, London, E.C.1, on Tuesday evenings, beginning October 5th. The course will consist of ten lectures on instrumentation and ten on automatic process control. The fee for the complete course is £3 3s.

PNEUMATICALLY OPERATED PRESSES.—A new range of pneumatic presses now being made by James Holt (Engineers), Ltd., Livsey Court Engineering Works, China Lane, Bolton, is made in four sizes of 600 lb, 1 ton, 3 tons and 5 tons capacity. The three smallest models are for bench mounting and can be arranged for hand or foot operation. These machines are designed to perform all standard pressing operations and can be fitted with a vibrator for riveting or peening work.

ASSOCIATION OF ENGINEERING DISTRIBUTORS.—The annual luncheon of the Association of Engineering Distributors will be held on Tuesday, October 26, 1954, at the Park Lane Hotel, Piccadilly, London, W.1. It is anticipated that approximately 200 members and their guests will be present at this function. Among the official guests will be representatives of the leading manufacturers' associations connected with the engineering industry, officials of the Ministry of Supply and other organisations. The luncheon will be preceded at 11 a.m. by the annual general meeting of the Association.

WORKS FOR MANUFACTURE OF CONDENSER AND FEED HEATING PLANT IN WHYALLA, AUSTRALIA.—To meet the growing need for generating plant in Australia a new works has been built at Whyalla to be operated by a company known as C. A. Parsons and Co. of Australia Ltd. This works will manufacture condensing and feed heating plant for installation and operation in association with steam turbo-alternators made at the Heaton Works of C. A. Parsons and Co., Ltd., and shipped to Australia. The Whyalla works is to be opened on September 27th by the Hon. Thomas Playford, the Premier of South Australia. The first section of the works consists of a single bay 400ft by 60ft, served by a 30-ton overhead travelling crane, and a 25ft wide annexe houses the administration and drawing-offices. Provision is made for expansion, the site area being 50 acres.

MAJOR DEVELOPMENT PROJECTS IN AUSTRALIA.—We have recently received a copy of a booklet entitled " Major Development Projects in Australia," which may be obtained from Australia House, Strand, London, W.C.2. The booklet lists 159 major development projects now in progress in Australia, concerning water conservation and supply, irrigation, electricity generation, town's gas, railway construction, seaport and airport development, and land settlement. The intense development taking place in Australia may be gauged from the total cost of all these projects, which exceeds £A600 million. This figure excludes the Snowy Mountains hydro-electric scheme, which alone accounts for more than £A400 million, so that developments exceeding £A1000 million are listed in the booklet, and several others for which no costs are given are included as well.

DRAKELOW " B " POWER STATION.—The British Electricity Authority has received the consent of the Minister of Fuel and Power to the construction of a new section of the Drakelow power station to be known as Drakelow " B." The new installation will comprise four turbo-alternator sets, each having a maximum capacity of 120MW, and will bring the total capacity of the generating plant at Drakelow up to 720MW. There will be four boiler units each having an evaporative capacity of 860,000 lb of steam per hour, and four cooling towers, each capable of dealing with 3,820,000 gallons of water an hour.

JUBILEE OF THE THERMIONIC VALVE.—The Institution of Electrical Engineers is to celebrate the Jubilee of the thermionic valve by holding a special meeting at Savoy place on November 16th next, fifty years after the date of Sir Ambrose Fleming's application for a British Patent for his thermionic valve. The proceedings will be opened at 2.30 p.m. by the Marquess of Salisbury, Lord President of the Council. A series of lectures will follow ; the first, on " The Genesis of the Thermionic Valve," by Professor G. O. Howe, and the second, " Thermionic Devices from the Development of the Triode up to 1939," by Sir Edward Appleton. To complete this review of progress there will be a lecture, at 5.30 p.m., on " Developments in Thermionic Devices Since 1939," by Dr. J. Thompson. An exhibition of apparatus will also be held at the Institution. Tickets for the admission of non-members of the I.E.E. are obtainable from the Secretary of the Institution, Savoy Place, Victoria Embankment, London, W.C.2.

" JOURNAL OF NUCLEAR ENERGY."—We welcome the first number of a periodical known as the *Journal of Nuclear Energy*, issued quarterly by Pergamon Press, Ltd., 242, Marylebone Road, London, N.W.1, at an annual subscription of £4 10s. In a foreword Sir John Cockcroft explains that the establishment of atomic energy projects in at least eight European countries has made it worth while to found a journal primarily for publication of technical articles from the staffs of these projects and their associated technical groups. The aim is to promote the interchange of ideas to form the basis of scientific and technological development in peace, without wasteful duplication of effort. There are ninety-two editorial pages in the issue before us and the articles include " The design of totally enclosed mechanical pumps with particular reference to a 50 h.p. sodium pump," by P. Fortescue ; " Economic power from fast breeder reactors," by C. A. Rennie ; and " The creep of aluminium during neutron irradiation," by E. R. W. Jones, W. Munro and N. H. Hancock. An article in French by a group of authors from the Commissariat à l'Energie Atomique describes an automatic control for nuclear reactors with particular reference to results obtained on the Saclay pile.

Personal and Business

MR. A. H. WALTON has been appointed field sales manager of Veeder-Root, Ltd.

MR. H. F. MACINTOSH has been appointed area sales manager, Scotland, of H. Widdop and Co., Ltd.

SIR HAROLD ROXBEE COX, M.I.Mech.E., F.R.Ae.S., has been elected a director of The Brush Group, Ltd.

WELLWORTHY, Ltd., Lymington, Hants, states that its telephone number has been changed to Lymington 2231.

MR. J. G. MCLEOD has been appointed works manager of Bowden (Engineers), Ltd., Victoria Road, Willesden Junction, N.W.10.

MR. NEVILLE C. WILLIAMS has been appointed London manager of Mountstuart Dry Docks, Ltd., and its associated companies.

TUBE INVESTMENTS, Ltd., states that it has been found possible to continue production at Jarrow Tube Works, Ltd., Jarrow-on-Tyne.

MR. G. H. ASBRIDGE has been appointed a director of Sentinel (Shrewsbury), Ltd., Shrewsbury, with responsibility for the machine tool division.

BABCOCK AND WILCOX, Ltd., announces the appointment of Mr. G. G. Buckingham as manager of its Manchester office, in succession to the late Mr. F. W. Woodfield.

MR. C. G. TANGYE, M.I.Mech.E., has been appointed chairman of the council of the British Internal Combustion Engine Research Association, in succession to Mr. H. Norman G. Allen.

STANDARD TELEPHONES AND CABLES, Ltd., announces the appointment of Mr. C. H. Foulkes, M.I.E.E., as head of its valve division and location manager at Dowlish Ford Mills, Ilminster, Somerset.

THE BOARD OF TRADE states that a Trade Commissioner's office is to be opened on October 1st at P.O. Box 1776, 516, Bradlow's Buildings, Abercorn Street, Bulawayo, Southern Rhodesia.

CLAUDE LYONS, Ltd., 76, Oldhall Street, Liverpool, 3, is opening a new factory, for the South of England, at Valley Works, 4–10, Ware Road, Hoddesdon, Herts (telephone, Hoddesdon 3007 ; telegrams, " Minmetkem, Hoddesdon ").

CHAMBERLAIN INDUSTRIES, Ltd., Staffa Works, Leyton, E.10, states that it has appointed Drummond Asquith (Sales), Ltd., King Edward House, New Street, Birmingham, 2, as sole distributor in the United Kingdom of the tube bending machinery manufactured in conjunction with Walter P. Hill Inc., Detroit.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 6d. each.

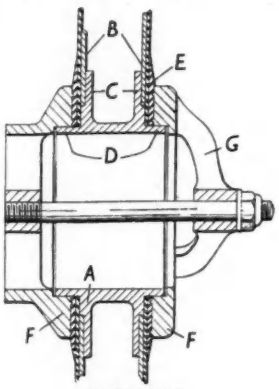
INTERNAL COMBUSTION ENGINES

714,068. May 11, 1951.—Compositions for Cleaning Radiators, Standard Oil Development Company, Elizabeth, New Jersey, U.S.A.

The invention is concerned with a method of and compositions for cleaning the radiators of engines. The cleaning and derusting procedure involves charging the radiator with a first aqueous solution containing approximately 0·5 lb each of oxalic acid and ammonium oxalate per 14 quarts of water, running the engine for a period of at least thirty minutes, draining the radiator, charging the radiator with a second aqueous solution containing approximately 1 oz each of tetrasodium pyrophosphate and sodium carbonate per 14 quarts of water, running the engine, preferably for a period of at least thirty minutes, and thereafter draining the second solution from the radiator. In order to evaluate the cleaning compositions and techniques of this invention a large number of actual tests were conducted employing a variety of cleaning agents and cleaning compositions, the results of which are given in the specification.—*August* 25, 1954.

714,097. February 1, 1952.—Flexible Tank Installations, Fireproof Tanks, Ltd., Armadores House, Bury Street, London, E.C.2. (*Inventor: Walter Frederick Locke.*)

The invention relates to a fuel tank installation for vehicles or craft comprising flexible tanks mounted in adjacent bays separated by a partition or bulkhead



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and having a short connecting pipe passing through an aperture in the partition. Referring to the drawing, the device comprises a tube or sleeve *A* passing through the aperture in the bulkheads *B* and has two parallel annular flanges *C* between which the bulkheads fit. The ends of the tube project as hollow spigots *D* on each side of the bulkheads. Each tank has an aperture around which is a resilient gasket *E*, cemented to the tank wall. Two clamping rings *F* are provided, each having two annular ribs on the face adjacent the gasket and being secured to a spider *G* having a central boss which is drilled to accommodate a drawbolt. The annular ribs on the clamping rings *F* ensure that there is a fluid-tight seal between the clamping rings and the gasket.—*August* 25, 1954.

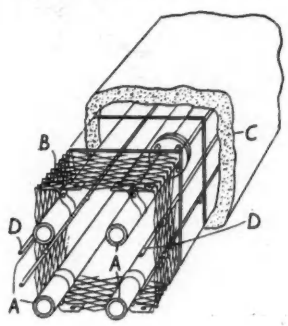
714,126. August 6, 1952.—Precombustion Chamber Diesel Engines, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

According to the invention a diesel engine fitted with a precombustion chamber consisting of a substantially spherically chambered part and a tubular part providing a duct communicating between the chamber and the cylinder space has supported within the chamber and in the path of the fuel jet a body which presents towards the jet a part-spherical surface. This body may be a ball or a part-spherical object carried by a pin mounted in the precombustion chamber walls. A particularly effective reduction of knocking can be obtained if the ball is heated, as by mounting it upon a glow plug or supporting it by the glow wire of such a plug. The plug is preferably a ceramic or metal body, and may be in the form of a hollow ball. As compared with a normal glow plug, which is disposed in the injection cone of the injection nozzle, the invention has the advantage that, on account of the greater surface offered to the fuel jet, more particles of fuel can be sprayed on to the surface and can be evaporated more quickly and more completely than in the case of the ordinary glow plug.—*August* 25, 1954.

OIL PIPELINES

714,469. July 25, 1952.—Oil Pipe Installations, McAndrew, Wormald and Co., Ltd., 51, Kilbirnie Street, Glasgow, C.5. (*Inventor: Alfred Wright.*)

The primary object of the invention is to provide an improved method of heating a pipe system.



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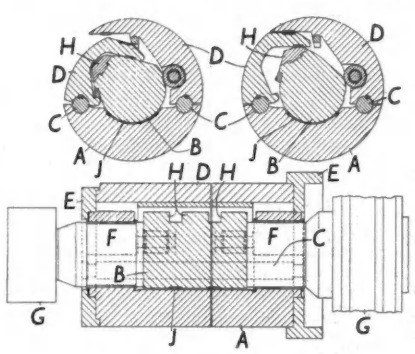
Referring to the drawing, the pipe system may consist of one oil pipe or a number of pipes *A* symmetrically arranged and enclosed within a chamber formed by a lining of perforated metallic sheet or network *B* and an insulating cover *C*. The pipes are supported by spacers or clips. The heating means for the system consists of electric heating elements *D* adjacent to the inner surfaces of the walls of the chamber. The elements are in contact with the network to improve the rate of heat transmission and evenness of heat distribution through the chamber. The walls of the chamber constituted by the network and the insulated cover are applied in sections, some of which are readily detachable for attention to the pipe joints. A modified system with steam heating is also shown in the specification.—*August* 25, 1954.

METALLURGY

714,177. November 27, 1951.—Drums for Carrying Coiled Metal Strips, Richard Thomas and Baldwins, Ltd., 47, Park Street, London, W.1. (*Inventors: Nathaniel Martin, Herbert Charles Davies, Peter Masterton Martin, and Elwyn Pinches.*)

In the rolling of a steel or other metal strip, it is customary to coil the strip on a drum after leaving the rolls. The coiling is usually effected under considerable tension, and in the case of a very long strip the mass to be carried by the drum may be large.



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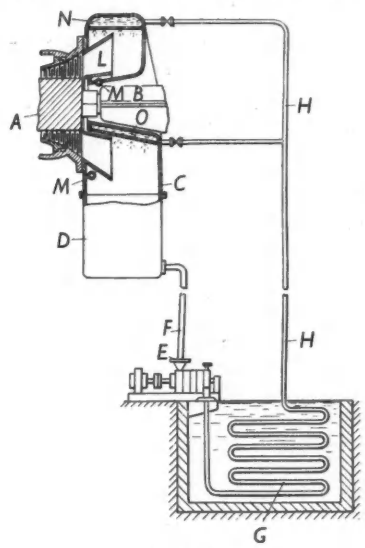
To facilitate removal of the coiled strip from the drum it is, in some forms, made collapsible, and it is to drums of this kind that the present invention relates. Referring to the drawings, the principal section *A* is shaped to form rather less than one-half of the circumference of the drum. The inner surface of this section has formed on it a recess to accommodate a part of the cylindrical surface of the cam *B*. The portions of the principal section extending from the edges of this recess are adapted to accommodate the pivots *C*, which carry the sub-sections *D*. At each end the principal section is provided with a recessed flange *E* which serves to limit the outward movements of the sub-sections under the action of the cam. The ends of the cam are shaped to form cylindrical shafts *F* which extend through the end flanges, and are supported by bearings *G* and one end of the shaft is connected to the drive. On one side of the cam is formed a lobe or a series of lobes *H* to act on the inner one of the two overlapping free edges of the sub-sections, and this sub-section acts on the corresponding edge of the other sub-section as shown in the drawings, for expanding the sub-sections to their normal working positions. The cylindrical surface of the cam bears on the surface of the recess in the principal section, or (as shown) on a liner *J* secured to the said surface, at least when the sections of the drum are in their normal working positions. By the construction described risk of flexure of the cam and/or of deformation of the sections is minimised. When the drum sections are in their normal working positions, they form with the cam a virtually solid structure in which little or no flexure can occur.—*August* 25, 1954.

STEAM TURBINES

714,705. October 16, 1951.—Steam Turbine Plants, Karl Andreas Röder, 13a, Post Rottendorf, near Würzberg, Germany.

To improve the efficiency of a turbine plant the casing at the discharge side is extended by a conical annular diffuser penetrating into an exhaust chest. In the chest is a spraying device, which discharges cooled water and the walls of the diffuser are cooled so that the boundary layer of the steam in the diffuser is continuously condensed and replaced. The back pressure at the outlet of the turbine is therefore reduced. As shown in the drawing, the rotor *A* of the turbine is supported in a bearing *B* surrounded by the wall of the exhaust chest *C*. The exhaust chest is bolted to a receptacle *D* which forms a storing chamber for collecting condensation. The circulating pump *E* withdraws part of the water from the receptacle *D* by means of conduit *F* and forces it through the cooler *G* and on through a pipe *H* to



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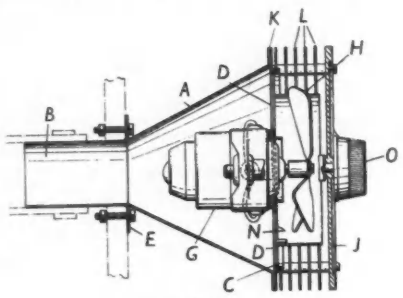
nozzles in the exhaust chest. Part of the water is continuously withdrawn from the receptacle *D* as feed water. The exhaust chest *C* is connected to an injector for drawing off the air from the chest which constitutes a jet condenser. The stuffing box for the rotor shaft at the outlet side of the turbine casing is sealed by means of water of condensation. The water is carried along by the rotor shaft and atomised in the exhaust chest so that it furthers the condensation of the steam in it. The turbine discharges in an annular diffuser *L* which extends into the exhaust chest. The conical outer wall of the diffuser diverges rapidly and the rate of diverging corresponds to that of the wall of the turbine casing. Measures, therefore, must be taken for removing the boundary layer of the steam at the conical walls of the diffuser and to this end the spraying device for condensing the steam in the exhaust chest of the turbine is used as shown. Spraying nozzles *M* are provided in the exhaust chest in order to direct water jets on the inner wall and the outer wall of the diffuser. The nozzles receive condensate from the conduit *H*. Moreover, boxes *N* and *O* are provided. By means of pipes and valves as shown these boxes are connected to the pressure conduit *H* of the circulating pump. The boxes have nozzles in their walls and the nozzles of the box *N* face the outer wall of the least one opening in the walls of the diffuser. By the cooling of the walls the steam of the boundary layer at the diffuser walls is condensed. A modified design is also shown in the specification.—*September* 1, 1954.

ROAD TRANSPORT

714,743. May 29, 1952.—Heating Devices for Motor Vehicles, Tudor Accessories, Ltd., Benlow Works, Silverdale Road, Hayes, Middlesex. (*Inventors: Fred Simon Worms and Robert Gordon Gammon.*)

The invention relates to heating devices for motor vehicles, using air which has been heated by

passage through the radiator of the engine cooling system is conducted to a distributor for dispersal within the vehicle body. In the drawing the distributor comprises an air receiving chamber *A* which is substantially conical in shape and at its apex has a tubular inlet member *B* to which the conduit is secured. The larger end or base of the chamber has a wall *C* in which one or more outlet openings are formed. In this particular construction two sector-shaped outlet openings *D* are provided. The chamber also has a flange *E*, by means of which it can be mounted. An electric motor *G* on the inner side of the wall *C* drives a fan *H* outside the air receiving chamber. A disc *J* spaced from the wall *C* is supported by studs from a radial flange *K*. A series of



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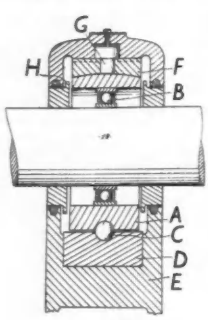
rings *L* are supported on the studs with spacer members between these. The disc together with the rings form a distributor chamber enclosing the fan and having outlet openings between the rings. A shutter *N* which co-operates with the openings *D* is associated with a baffle and a control knob *O* is provided for adjusting the shutter and baffle simultaneously.—*September* 1, 1954.

BEARINGS AND SUPPORTS

714,568. December 30, 1952.—BEARINGS, The Glacier Metal Company, Ltd., 368, Ealing Road, Alperton, Wembley, Middlesex. (*Inventor : Phil Prince Love.*)

The invention relates to improvements in self-aligning pedestal ball, roller or needle bearing assemblies. Referring to the drawing, a bearing unit may comprise a casing *A* housing a ball bearing *B* or a pair of ball bearings, of conventional construction. The casing is supported by a ball and socket mounting comprising a ball *C*, which seats in a recess in the bottom of the casing and in a recess in a member *D* supported on internal abutments in a housing *E*. At its upper side the casing is located by means of a bar *F* pivoted to the upper part of the housing by a headed pin *G* located in a recess so as to be



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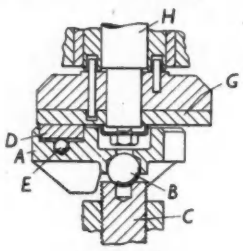
capable of swinging about a vertical axis passing through the centre of the bore and socket mounting. The bar slides in a slot in the top of the casing, which extends parallel to the bore. The bottom of the slot and the bottom of the bar may be curved in the longitudinal direction to a radius from the centre of the ball *C*. By such an arrangement clearance between the parts may be reduced to a minimum to ensure that the bearing unit will be held firmly seated on the ball and socket mounting. A cover plate for the top of the housing held in place by a screw as shown and the housing comprises a removable upper part held in position by the bearing bolts. The ball bearing *B* carries a journal member which may be provided with conventional oil thrower elements *H*, suitable sealing means, such as felt rings being interposed between the elements and the housing. Similar designs for roller and needle bearings are also shown in the specification.—*September* 1, 1954.

714,650. June 25, 1952.—THRUST BEARINGS, Chance Brothers, Ltd., Glass Works, Smethwick 40, Birmingham. (*Inventor : Louis Bertram Henry Hallett.*)

The invention relates to thrust or footstep bearings for supporting a vertically mounted rotary body.

As the drawing shows, the lower member *A* is supported on a central ball *B*, which is itself supported on the upper end of an abutment *C*. The upper member comprises three equi-spaced radial arms, in the outer end of each of which is formed a circular recess for accommodating a circular pad *D*, each pad being supported in its recess by a central ball *E*. The upper member *G* of the bearing, which is secured to the spindle *H* or other rotary body to be supported, has a flat under surface which is supported



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on the pads *D*. The part *G* is secured to the spindle *H* by a washer and nut. The bearing is intended for use more particularly for supporting the vertical rotor of an electrically driven submersible pump in which case the abutment *C* may consist of a threaded stub spindle adjustably secured in the lower end cover of the pump.—*September* 1, 1954.

Launches and Trial Trips

DAVID POLLOCK, self-trimming collier ; built by Hall Russell and Co., Ltd., for the North Thames Gas Board ; length overall 339ft, length between perpendiculars 320ft, breadth moulded 46ft, depth moulded 22ft 4in/27ft 10in, deadweight 4600 tons on 20ft draught ; four holds ; "North-Eastern Reheat" direct-acting, triple-expansion steam engine, 1275 i.h.p., superheated steam at 220 lb per square inch supplied by two oil-fired cylindrical boilers. Trial, September 2nd.

PATHFINDER, pilot vessel ; built by Philip and Son, Ltd., for the Pilotage Department of Trinity House ; length between perpendiculars 157ft, breadth moulded 30ft, depth moulded 14ft ; twenty-two pilots ; two sets of British Polar diesel engines, each developing 500 b.h.p. at 325 r.p.m., two 60kW diesel-driven generators. Launch, September 13th.

PONTIA, oil tanker ; built by Harland and Wolff, Ltd., for Pelagos A/S, Norway ; length overall 498ft 6in, length between perpendiculars 465ft, breadth moulded 61ft 6in, depth moulded 35ft 6in, deadweight 13,200 tons on 27ft 10in draught ; twenty-four cargo oil tanks, two cargo pump rooms ; Harland-B. and W. single-acting four-stroke diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 115 r.p.m., two single-ended multitubular boilers, one 75kW diesel-driven generating set, two 50kW steam-driven generating sets. Trial, September 16th.

Contracts

THE NATIONAL GAS AND OIL ENGINE COMPANY, Ltd., has received from the Kellogg International Corporation an order for diesel and dual fuel engines. This equipment will be supplied to Imperial Chemical Industries, Ltd., for driving compressors at its No. 2 Olefine Plant, Wilton, Yorkshire. The total power involved is approximately 11,000 b.h.p., to be obtained from thirteen engines.

THE NORTH SHORE GAS COMPANY, North Sydney, Australia, has placed an order with the Power-Gas Corporation (Australasia) Pty., Ltd., for the supply, delivery and erection at Willoughby of a 1,000,000 cubic feet capacity, three-lift, spiral guided gas holder, complete with steel tank. The Power-Gas Corporation (Australasia) Pty., Ltd., is a subsidiary of the Power-Gas Corporation, Ltd., Stockton-on-Tees.

THE New South Wales Government, Department of Railways, has placed an order with Metropolitan-Vickers Electrical Company, Ltd., through its associated company, Australian General Electric Pty., Ltd., for eighty sets of electric traction equipment. These equipments are for multiple-unit rolling stock (eighty motor coaches and eighty trailers) being built for the Sydney suburban and inter-urban railways ; forty sets will be used on trains running on the new electrification between Sydney and Lithgow, over the steep gradients of the Blue Mountains. The value of the new order is over £1,000,000 (sterling). The equipment will be of Metropolitan-Vickers design, and will be manufactured partly by the company's works at Sheffield and Manchester and partly by the A.G.E. works at Auburn, N.S.W.

THE GENERAL ELECTRIC COMPANY, Ltd., has received an order from the British Transport Commission for the complete electrical equipment for thirty-two four-coach, multi-unit trains to operate on the forthcoming Southend and Chelmsford extensions of the Eastern Region Liverpool Street–Chelmsford electrification. The equipment is designed for 1500V d.c. Each train unit will consist of a driving trailer, motor coach, trailer and second driving trailer. The motor coaches will be powered by four axle-hung motors, with series-parallel control by underframe-mounted electro-pneumatic contactor equipment providing automatic acceleration with two full-field and one weak-field continuous running notches. The mechanical parts of the rolling stock will be built at the Eastleigh Works of British Railways. In general, the electrical equipment will be similar to that designed and built by the G.E.C. for the eight three-coach sets which went into service on the Manchester–Glossop section of the British Railways Manchester–Sheffield electrification in June this year.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASLIB

To-day to Mon., Sept. 24th to 27th.—Church House, Westminster, London, S.W.1, 29th Annual Conference.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 29th.—LONDON SECTION : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Computing Circuits in Flight Simulators," A. E. Cutler, 6.30 p.m.

ENGINEERS GUILD

Thurs., Sept. 30th.—METROPOLITAN BRANCH : Caxton Hall, Westminster, London, S.W.1, Annual General Meeting, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Oct. 5th.—EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, "Trends in Industrial Instrumentation," A. B. Dryburgh, 7 p.m.——LONDON BRANCH : Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Controlled Air Conditions in Factories," D. J. Hyam, 7 p.m.

Wed., Oct. 6th.—SOUTHAMPTON BRANCH : Polygon Hotel, Southampton, "The Control of Maximum Demand and Power Factor," A. W. Ingram, 7.30 p.m.

Thurs., Oct. 7th.—PETERBOROUGH BRANCH : Dujon Cafe, Market Place, Peterborough, "Plant Maintenance and Productivity," R. A. Rogers, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Sept. 29th.—LONDON BRANCH : Waldorf Hotel, Aldwych, London, W.C.2, "The Casting of an Aluminium Wheel," J. R. Harrison, 7.30 p.m.

Sat., Oct. 2nd.—LANCASHIRE BRANCH : Engineers' Club, Albert Square, Manchester, "Semi-Continuous Casting of Bronze," E. C. Elwood, 2.30 p.m.——WALES AND MON. BRANCH : Engineers' Club, Cardiff, "Some Aspects of Shell Moulding Technique," D. F. Bailey, 6 p.m.

Mon., Oct. 4th.—SHEFFIELD BRANCH : Sheffield and Eccleshall Co-operative Society Restaurant, Sheffield, Presidential Address, "Science Hand-in-Hand with Labour," E. Ayres, 7.15 p.m.

INSTITUTE OF FUEL

Wed. and Thurs., Oct. 6th and 7th.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, Conference on a Special Study of Sulphur Removal and Recovery from Fuels, 10 a.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Sept. 28th.—85, Minories, London, E.C.3, Presidential Address, H. A. J. Silley, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 4th.—SCOTTISH CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Design of Automotive Piston and Ring Assemblies," L. Howell, 7.30 p.m.

Tues., Oct. 5th.—N.W. CENTRE : Victoria and Station Hotel, Preston, "Post-War Development in Brake Linings," P. Tonge and M. Healey, 7.30 p.m.

Wed., Oct. 6th.—EASTERN CENTRE : Lion Hotel, Cambridge, "Heavy Duty Batteries for Commercial and P.S. Vehicles," C. P. Lockton, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

To-day, Sept. 24th.—MIDLANDS ASSOCIATION : Summer Meeting at University of Birmingham and at Stratford-upon-Avon.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Oct. 4th.—N.E. BRANCH : Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Engineering Costing and Estimating," W. S. Shield, 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Thurs., Sept. 30th.—E. MIDLANDS BRANCH : Grand Hotel, Leicester, Opening Meeting, "Creative Engineering," J. H. R. Nixon, 6.30 p.m.

Tues., Oct. 5th.—AUTOMOBILE DIVISION : 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting, Address by the Chairman of the Division, 5.30 p.m.——S. WALES BRANCH : Mackworth Hotel, Swansea, Address by the Chairman, L. J. Kastner, 6 p.m.

Wed., Oct. 6th.—SOUTHERN BRANCH : Technical College, Brighton, "Patents for Inventions," R. E. Tree, 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Thurs., Sept. 30th.—LINCOLN SECTION : Ruston Club, Unity Square, Lincoln, "How the Production Engineer can be helped by the Metallurgist," J. D. Jevons, 7.30 p.m.

Mon., Oct. 4th.—HALIFAX SECTION : George Hotel, Huddersfield, "Industrial Uses of 'Terylene' Polyester Fibre," D. N. Marvin, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Oct. 5th.—N. IRELAND BRANCH : College of Technology, Belfast, "Concrete as an Engineering Material," J. Singleton-Green, 6.45 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Sept. 27th.—Engineers' Club, Albert Square, Manchester, "Forty Years with Rubber," E. H. Wallace, 6.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Sept. 24th.—14, Rochester Row, Westminster, London, S.W.1, "Some of the Problems of Bomber Design," D. Keith-Lucas, 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., Sept. 30th.—GRADUATES' AND STUDENTS' SECTION : 4, Hamilton Place, London, W.1, "Air-to-Air Photography," Russell Adams, 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 6th.—CORROSION GROUP AND THE MICROBIOLOGY GROUP : Burlington House, Piccadilly, London, W.1, "The Influence of Micro-Organisms on the Corrosion of Metals," F. Wormwell and T. W. Farrer, 6.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Wed., Sept. 29th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, 2, "Health in Industry," M. W. Robinson, 6.45 p.m.